DOCUMENT RESUME

ED 473 913 SO 034 623

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TITLE	Global Environmental Problems: Implications for U.S. Policy. Tenth Edition. Teacher Resource Book [and Student Text]. Public Policy Debate in the Classroom. Choices for the 21st Century.
INSTITUTION	Brown Univ., Providence, RI. Thomas J. Watson, Jr. Inst. for International Studies.
ISBN	ISBN-1-891306-53-7
PUB DATE	2003-00-00
NOTE	84p.
AVAILABLE FROM	Choices Education Program, Watson Institute for International Studies, Brown University, Box 1948, Providence, RI 02912 ($15 per teacher/student set). Tel: 401-863-2809; Web site: http://www.watsoninstitute.org/index2.cfm.
PUB TYPE	Guides - Classroom - Learner (051) -- Guides - Classroom - Teacher (052)
EDRS PRICE	EDRS Price MF01 Plus Postage. PC Not Available from EDRS
DESCRIPTORS	*Conservation (Environment); Critical Thinking; Economic Factors; Foreign Policy; *Global Approach; *Public Policy; Secondary Education; Simulation; *World Problems
IDENTIFIERS	*Ecological Perspective; *Environmental Problems; Global Awareness; Global Change; Global Issues

ABSTRACT

Scientists have increasingly focused attention on far-reaching environmental threats, such as climate change, ozone depletion, and deforestation, that transcend national boundaries. A new concept, global environmental problems, has entered the public arena, particularly in the area of foreign policy and economic matters. This unit explores the relationship between public policy in the United States and the ecological health of the planet. Students join in the process of assessing global environmental problems, grappling with tough questions that are confronting U.S. policymakers. The unit's framework is four distinct options that allow students to consider a range of alternatives for U.S. policy toward global environmental problems. Exploring a wide-ranging spectrum, students can gain an understanding of the values underlying specific policy recommendations. The Teacher Resource Book contains a day-by-day lesson plan and student activities. The lesson plan begins by introducing students to the concept of global environmental problems. The second day of the lesson plan engages students in a role play that delineates the contrasting perspectives of different regions of the world toward environmental issues. An optional science lesson examines humanity's impact on the global carbon cycle. After studying the scientific causes and international ramifications of global environmental problems, students evaluate U.S. options in the course of a 2-day simulation. They conclude by applying what they have learned to developing their own recommendations for U.S. policy. Teachers may also find the "Alternative Three-Day Lesson Plan" useful. The student text invites students to weigh the significance of global environmental problems in the formulation of U.S. foreign policy. The unit traces the entry of global warming, ozone depletion, population pressures, and other worldwide environmental threats into the sphere of public policy. Students weigh the

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choices and trade-offs involved in protecting the environment. The first section of the background reading has been designed to introduce students to the most significant global environmental problems, while Parts 2 and 3 explore the economic and political dimensions of the environmental challenges facing the planet. Lists 16 supplementary resources, including Web site addresses. (BT)

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Sarah Cleveland Fox

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Global Environmental Problems: Implications for U.S. Policy

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History and Current Issues for the Classroom

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ACKNOWLEDGMENTS

Global Environmental Problems: Implications for U.S. Policy was developed by the Choices for the 21st Century Education Program staff with the assistance of the research staff of the Watson Institute for International Studies, scholars at Brown University, and several other experts in the field. We wish to thank the following researchers for their invaluable input:

Robert Chen, *former Assistant Professor, World Hunger Program, Brown University*

Jarat Chopra, *Research Associate, Watson Institute for International Studies, Brown University*

Hilary F. French, *Senior Researcher, Worldwatch Institute*

Theodore D. Goldfarb, *Professor, Department of Chemistry, State University of New York at Stony Brook*

Steven Hamburg, *Director, Global Environment Program, Watson Institute for International Studies; Associate Professor, Center for Environmental Studies, Brown University*

Robert Kates, *former Professor, World Hunger Program, Brown University*

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Sir Crispin Tickell, *Chancellor, University of Kent at Canterbury, UK*

Harold Ward, *former Director, Center for Environmental Studies, Brown University*

Richard Wetzler, *Associate Professor (Research), Watson Institute for International Studies, Brown University*

We wish to thank the following organizations: the American Enterprise Institute, the American Petroleum Institute, the Atomic Energy Commission, the Environmental Defense Fund, Greenpeace, the Heritage Foundation, the Natural Resources Defense Council, the Rainforest Action Network, the Rainforest Alliance, the United Nations Conference on Environment and Development, the United Nations Environment Programme, the U.S. Citizens Network on UNCED, the U.S. Department of State, the Worldwatch Institute, the World Bank, and the World Resources Institute.

Special thanks to the high school teachers who tested drafts of this material in their classrooms prior to publication: Don Bakker of North Eastham, Massachusetts; Candace Fisk of Springfield, Missouri; Marilyn Gallagher of Yonkers, New York; and Mick Hale of Omaha, Nebraska. Thanks also to David Magnussen and Jed Fitzgerald of Cohasset, Massachusetts, and to Margorie Porter of Woodstock, Connecticut, for their contributions to the development and review of material for inclusion in environmental science courses. We also wish to thank Karl Berger and Erik Bleich for their helpful contributions to an earlier edition of this unit.

We thank Michael Barton of Massachusetts, Patricia Clancy of New Jersey, and Ron Levitsky of Illinois for helping us to revise the format of Choices units to make them responsive to a wider variety of student learning styles.

Global Environmental Problems: Implications for U.S. Policy is part of a continuing series on public policy issues. New units are published each academic year, and all units are updated regularly.

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January 2003

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The Choices for the 21st Century Education Program develops curricula on current and historical international issues and offers workshops, institutes, and in-service programs for high school teachers. Course materials place special emphasis on the importance of educating students in their participatory role as citizens.

The Choices for the 21st Century Education Program is a program of the Watson Institute for International Studies at Brown University.

Thomas J. Biersteker
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SUGGESTED FIVE-DAY LESSON PLAN

About the Choices Approach ii

Note to Teachers 1

Integrating This Unit into Your Classroom 2

DAY ONE — Defining Global Environmental Problems 3
  Homework (before Day One): Part I of the background reading and "Study Guide — Part I"
  Homework: Part II of the background reading and "Study Guide — Part II"

DAY TWO — Global Environmental Problems in the International Arena 7
  Homework: Part III of the background reading and "Study Guide — Part III"

OPTIONAL LESSON — Understanding the Carbon Cycle 10
  Homework (before the lesson): "Following the Path of the Carbon Cycle" and "Study Guide"

DAY THREE — Role Playing the Four Options: Organization and Preparation 15
  Homework: "Expressing Key Values"

DAY FOUR — Role Playing the Four Options: Debate and Discussion 22
  Homework: "Focusing Your Thoughts" and "Your Option Five"

DAY FIVE — Looking into the Future 24

Key Terms and Concepts 27

Making Choices Work in Your Classroom 29

Alternative Three-Day Lesson Plan 33

THE CHOICES FOR THE 21ST CENTURY EDUCATION PROGRAM is a program of the Watson Institute for International Studies at Brown University. CHOICES was established to help citizens think constructively about foreign policy issues, to improve participatory citizenship skills, and to encourage public judgment on policy priorities.

THE WATSON INSTITUTE FOR INTERNATIONAL STUDIES was established at Brown University in 1986 to serve as a forum for students, faculty, visiting scholars, and policy practitioners who are committed to to analyzing contemporary global problems and developing initiatives to address them.

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About the Choices Approach

Choices for the 21st Century Program curricula are designed to make complex international issues understandable and meaningful for students. Using an innovative approach to student-centered instruction, Choices units develop critical thinking and civic judgment — essential ingredients of responsible citizenship.

Understanding the Significance of History: Each Choices unit provides students with a thorough introduction to the topic under consideration. Students gain an understanding of the historical background and the status of current issues. In this way, they see how history has shaped our world. With this foundation, students are prepared to thoughtfully consider a variety of perspectives on public policy.

Exploring Policy Alternatives: Each Choices unit is built around a framework of alternative policy options that challenges students to consider multiple perspectives and to think critically about the issue at hand. Students are best able to understand and analyze the options through a cooperative learning/role-play activity. In groups, students explore their assigned options and plan short presentations. The setting of the role-play may be a Congressional hearing, meeting of the National Security Council, or an election campaign forum. Student groups defend their policy options and, in turn, are challenged with questions from their classmates. The ensuing debate demands analysis and evaluation of the many conflicting values, interests, and priorities reflected in the options.

Exercising Civic Judgment: Armed with fresh insights from the role-play and debate, students are challenged to articulate original, coherent policy options that reflect their own values, priorities, and goals as individuals and citizens. Students' views can be expressed in letters to Congress or the White House, editorials for the school or community newspaper, persuasive speeches, or visual presentations.

Why Use the Choices Approach? Choices curricula are informed by current educational research about how students learn best. Studies have consistently demonstrated that students of all abilities learn best when they are actively engaged with the material rather than listening passively to a lecture. Student-centered instructional activities motivate students and develop higher-order thinking skills. However, some high school educators find the transition from lecture format to student-centered instruction difficult. Lecture is often viewed as the most efficient way to cover the required material. Choices curricula offer teachers a flexible resource for covering course material while actively engaging students and developing skills in critical thinking, persuasive writing, and informed citizenship. The instructional activities that are central to Choices units can be valuable components in any teacher's repertoire of effective teaching strategies. Each Choices unit includes student readings, a framework of policy options, suggested lesson plans, and resources for structuring cooperative learning, role-plays, and simulations. Students are challenged to:

- recognize relationships between history and current issues
- analyze and evaluate multiple perspectives on an issue
- understand the internal logic of a viewpoint
- engage in informed debate
- identify and weigh the conflicting values represented by different points of view
- reflect upon personal values and priorities surrounding an issue
- develop and articulate original viewpoints on an issue
- communicate in written and oral presentations
- collaborate with peers

Teachers who use Choices units say the collaboration and interaction that take place are highly motivating for students. Opportunities abound for students to contribute their individual talents to the group presentations in the form of political cartoons, slogans, posters, or characterizations. These cooperative learning lessons invite students to take pride in their own contributions and the group product, enhancing students' self-esteem and confidence as learners. Choices units offer students with diverse abilities and learning styles the opportunity to contribute, collaborate, and achieve.

Note to Teachers

Until recently, concern about the environment revolved almost exclusively around local and national problems. The smog of Southern California, the pollution of the Great Lakes, and the nuclear accident at Three Mile Island dominated our thinking about environmental issues. In the past fifteen years, however, scientists have increasingly focused attention on more far-reaching environmental threats, such as climate change, ozone depletion, and deforestation, that transcend national boundaries. A new concept — global environmental problems — has entered the public arena, especially in the area of foreign policy and economic matters.

Global Environmental Problems: Implications for U.S. Policy explores the relationship between public policy in our country and the ecological health of the planet. With this unit, students will join in the process of assessing global environmental problems and grapple with the same tough questions that are confronting U.S. policymakers.

At the core of the unit is a framework of four distinct options that allows students to consider a range of alternatives for U.S. policy toward global environmental problems. By exploring a wide-ranging spectrum of alternatives, students gain a deeper understanding of the values underlying specific policy recommendations. The background reading was written with the complexities of the debate on the environment in mind. Part I outlines the causes and effects of climate change, ozone depletion, acid rain and water pollution, deforestation and desertification, the decline of biodiversity, and biosafety. Part II explains resources, their consumption, and how the developed world, the former Soviet bloc, newly industrializing countries, and developing nations each pose distinct threats to the global environment. Finally, Part III discusses the environmental agenda of the international community and examines key components of the controversy over environmental policy in the United States.

Suggested Five-Day Lesson Plan: The Teacher Resource Book accompanying *Global Environmental Problems: Implications for U.S. Policy* contains a day-by-day lesson plan and student activities. The lesson plan begins by introducing students to the concept of global environmental problems. The second day of the lesson plan engages students in a role play that delineates the contrasting perspectives of different regions of the world toward environmental issues. In addition, there is an optional science lesson that examines humanity's impact on the global carbon cycle. After studying the scientific causes and international ramifications of global environmental problems, students evaluate U.S. options in the course of a two-day simulation. Finally, they apply what they have learned to developing their own recommendations for U.S. policy. You may also find the "Alternative Three-Day Lesson Plan" useful.

- **Alternative Study Guides:** Each section of background reading is accompanied by two distinct study guides. The standard study guide is designed to help students harvest the information provided in the background readings in preparation for analysis and synthesis within classroom activities. The advanced study guide requires analysis and synthesis prior to class activities.

- **Vocabulary and Concepts:** The background reading in *Global Environmental Problems: Implications for U.S. Policy* addresses subjects that are complex and challenging. To help your students get the most out of the text, you may want to review with them "Key Terms" found in the Teacher Resource Book (TRB) on page TRB-27 before they begin their assignment. A "Global Environmental Problems Issues Toolbox" is also included on page TRB-28. This provides additional information on key concepts of particular importance to understanding the foundations the debate over U.S. environmental policy.

The lesson plan offered in *Global Environmental Problems: Implications for U.S. Policy* is a guide. Many teachers choose to devote additional time to certain activities. We hope that these suggestions help you in tailoring the unit to fit the needs of your classroom.

Integrating This Unit into Your Curriculum

Units produced by the Choices for the 21st Century Education Program are designed to be integrated into a variety of social studies courses. Because of the interdisciplinary approach of *Global Environmental Problems: Implications for U.S. Policy*, science teachers may find a place for the unit in their classrooms as well. Below are a few ideas about where *Global Environmental Problems: Implications for U.S. Policy* might fit into your curriculum.

The Role of the International Community: Global environmental problems are at the forefront of an emerging set of international issues that transcend national borders. Along with refugee crises, nuclear proliferation, AIDS, drug trafficking, and terrorism, global environmental problems have redefined the agenda of the international community in recent decades. They have also focused renewed attention on the role of the United Nations (UN) and other international organizations. As the UN enters its second half-century, Americans are often ambivalent about our country's relationship with the global body. On the one hand, the threat of global environmental problems and other transnational issues has elevated the importance of international cooperation. On the other hand, many Americans fear that expanding the UN's authority will infringe on our country's sovereignty and create a new layer of bureaucratic red tape. *Global Environmental Problems: Implications for U.S. Policy* offers an opportunity to examine these issues in the classroom.

Economics and the Environment: Since the first agricultural societies took hold, humanity has struggled to balance its economic needs with the health of the natural environment. History shows that even in ancient times short-sighted irrigation practices and overgrazing led to the degradation of the land in Mesopotamia, Egypt, and other fertile river valleys. Today, environmental concerns have entered into the study of modern economic systems. The dangers of climate change, ozone depletion, and other environmental problems are often seen as limits to economic growth. Environmentalists have put forth their own economic models for sustainable development. Others view environmental problems as challenges that are best overcome by spurring market forces to develop new techniques and technologies. For high school students, the integration of global environmental problems into our thinking about economics adds a new dimension to social studies and science.

The Industrial Revolution: The global environmental problems that we face today are an outgrowth of the Industrial Revolution that began more than two centuries ago in Britain. As industrialization spread across Europe, North America, and Japan in the 19th century, there were few voices raised on behalf of environmental protection. Widespread concern about pollution in the United States did not emerge until after World War II. Suggestions that industrialization may be linked to long-term climatic change or depletion of the ozone layer were hardly considered. With the pace of industrialization today gathering steam in much of the developing world, scientists are increasingly concerned about the environmental consequences. *Global Environmental Problems: Implications for U.S. Policy* invites a comparison between the Industrial Revolution that took place in the West and Japan and the ongoing development in the newly industrializing countries of East Asia and Latin America.

Environmental Science: Solutions to global environmental issues are negotiated in political contexts, both domestic and international. The efforts to resolve these issues are complicated by disputes over policy priorities and the science behind these environmental concerns. How quickly is the world's population really growing? Can the economic impact of climate change be predicted? *Global Environmental Problems: Implications for U.S. Policy* supplements science curriculum and helps students understand the competing values and trade-offs that affect the interpretation of scientific information by policymakers.

Defining Global Environmental Problems

Objectives:

Students will:
- Define the concept of global environmental problems.
- Analyze the global environmental problems that have resulted from the development of the Amazon Basin.
- Weigh the challenges and trade-offs involved in protecting the global environment.

Required Reading:

Before beginning the unit, students should have read Part I of the background reading in the student text (pages 1-7) and completed "Study Guide — Part I" in Teacher Resource Book (TRB-4) or the "Advanced Study Guide — Part I" (TRB-5) .

Handouts:

- "Exploring the Rainforest" (TRB-6)

In the Classroom:

1. *Distinguishing Global Environmental Problems* — Call on students to offer examples of "environmental problems." List the most frequently cited examples on the chalkboard and ask students to identify the problems that are mostly closely connected to their community.

2. *Exploring the Rainforest* — Distribute "Exploring the Rainforest" and instruct students to read the first part of the article. Ask students to explain the role of the Amazon Basin in the global environment. How is the health of the rainforest linked to the problems of climate change and the decline of biodiversity? Instruct students to read the second part of "Exploring the Rainforest." Why is the fate of the Amazon Basin's rainforest considered a "global" environmental problem? Why has the concept of global environmental problems emerged only in the last few decades?

3. *Weighing Political Considerations* — Note that many scientists argue that the rainforest ecosystem should be considered a trust of humanity, similar to the status of Antarctica and the oceans. Does this sentiment conflict with our notion of national sovereignty? Point out that Brazil's carbon dioxide emissions are less than one-seventh of U.S. contributions. In light of our high levels of consumption and our past destruction of much of America's forest, do we have the right to protest the policies of Brazil? How does the United States contribute to the destruction of the rainforest (e.g., role of American transnational corporations, demand in the United States for wood, beef, and other agricultural products, etc.)? What role should the United States play in addressing this issue?

Homework:

Students should read Part II of the background reading in the student text (pages 8-12) and complete "Study Guide — Part II" (TRB-8) or the "Advanced Study Guide — Part II" (TRB-9).

Name:

Study Guide — Part I
Global Environmental Problems

1. List three issues that are behind the current anxieties surrounding environmental problems.

a.

b.

c.

2. Complete the chart below filling in the causes and effects of each environmental problem.

Environmental Problem	Causes	Effects
Climate change		
Ozone depletion		
Acid rain		
Water pollution		
Deforestation and desertification		
Decline of biodiversity		

Name:

Advanced Study Guide — Part I
Global Environmental Problems

1. Summarize the causes and effects of each of the following problems.

Climate change:

Ozone depletion:

Acid rain:

Water pollution:

Deforestation and desertification:

Decline of biodiversity:

2. How are genetically modified foods and the concept of environmental equity linked?

Exploring the Rainforest

Part I — A living resource

The Amazon River basin of South America is one of the world's most remarkable ecosystems. Covering an area larger than Western Europe, the Amazon Basin was largely untouched by modern society until a few decades ago.

The Amazon Basin's vast rainforest performs a vital function in maintaining the world's climate. Scientists call the rainforest the "lungs of the world" because of its role in producing oxygen and absorbing carbon dioxide. Along with the woodlands of Russia, the Amazon Basin's rainforest holds nearly half of the carbon stored in the world's forests. The destruction of the rainforest, according to most scientists, would lead to higher levels of carbon dioxide in the atmosphere and accelerate the process of climate change. Additionally, deforestation could lead to significant changes in the circulation and distribution of water across the South American continent, and possibly parts of North America.

VENEZUELA
GUYANA
FRENCH GUIANA
COLOMBIA
SURINAME
ECUADOR
Amazon Basin
PERU
BRAZIL
BOLIVIA
PARAGUAY
CHILE
ARGENTINA
URUGUAY

The Amazon Basin also contains the planet's richest variety of plant and animal life. Some of the Amazon Basin's plants provide a source of valuable medicines. D-tubocurarine, for example, is derived from curare — a dried extract of the bark and stems of plants that grow in the Amazon Basin. South American Indians have long poisoned the tips of their arrows with curare. In hospitals throughout the world, d-tubocurarine serves as the basis for drugs that are commonly used to relax muscles without deep anesthesia during surgery and to treat multiple sclerosis, Parkinson's disease, and other muscular disorders.

There are eighteen drugs currently used just in the United States that are obtained directly from tropical forest plants, including treatments for malaria, glaucoma, Hodgkin's disease, and leukemia. Many scientists believe that the pharmaceutical potential of the rainforests is enormous, and largely untapped.

Part II — Threats to the rainforest

Just as past generations of Americans tamed the frontier in our country by clearing millions of acres of woodland, people in South America today look at the Amazon Basin as an area of hope and opportunity. In recent decades, cattle ranchers, farmers, and loggers have been clearing the Amazon Basin's rainforest at a rapid rate. Roughly 16 percent of the rainforest has been destroyed so far, typically by fires set during the dry season. Most of the cleared land has been converted to cattle pasture.

In Brazil, home to at least four-fifths of the Amazon Basin's rainforest, the government has taken measures to stop illegal logging and control large-scale burning. At the same time, however, Brazil has pushed ahead with development projects in the region. New roads are being built into the rainforest while radar is being applied to map the region's mineral resources.

As Brazil's economy gained strength in the mid-1990s, the destruction of the rainforest increased. According to the Brazilian government, an area of rainforest larger than New Jersey was cleared during the 1994-95 dry season — the highest level of destruction ever recorded.

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Global Environmental Problems in the International Arena

Objectives:

Students will:

- Compare environmental concerns in four distinct regions of the world.
- Articulate international viewpoints in a collaborative role-play setting.
- Assess the prospects for international consensus on global environmental problems.

Required Reading:

Students should have read Part II of the background reading in the student text (pages 8-12) and completed "Study Guide — Part II" (TRB-8) or the "Advanced Study Guide — Part II" (TRB-9).

In the Classroom:

1. *Creating Small Groups* — Divide the class into four groups. Explain that students will represent different regions of the world participating in the UN Commission on Sustainable Development (UNCSD), a body created to follow up the work of the Earth Summit held in June 1992. Note that the main task of UNCSD is to implement Agenda 21, a non-binding, eight hundred-page set of guidelines adopted by Earth Summit delegates to balance the needs of economic development and environmental protection.

2. *Defining Roles* — Assign each group one of four regions: the developed world; the former Soviet bloc countries; the newly industrializing countries; or the developing world. Call on students to identify the largest countries of each region. Instruct each group to formulate a brief presentation on the environmental problems and concerns of its region. For example, representatives of the newly industrializing countries should note that their people are beginning to suffer from the ill effects of industrial pollution and rapid urbanization. At the same time, they would be wary of environmental restrictions that would hamper their development and deny their people an opportunity to reach a standard of living comparable to that of the developed world. Students should base their presentations on the "Local Perspectives" section, pages 10-12, in Part II of the background reading.

3. *Acquiring a Global Perspective* — Instruct each group to select one member to record the ideas of the group and another to deliver the presentation. After the groups have given their presentations, ask students to analyze the viewpoints of the four regions. What are the major points of contention? How is the United States perceived within each region? What is the likelihood of global consensus on environmental issues?

Homework:

Students should read Part III of the background reading in the student text (pages 13-19) and complete "Study Guide — Part III" (TRB 16-17) or "Advanced Study Guide — Part III" (TRB-18).

Name: ______________________________

Study Guide — Part II

The Environment and Economic Development

1. Why has population growth increased?

2. The consumption rate of the average American is __________ times higher than that of an average South Asian or African.

3. Which three fuels account for roughly ninety percent of the world's fossil fuel usage?

4. Why has interest in energy conservation in the United States decreased since the late 1980s?

5. Order the following energy sources by the rate of growth of their use between 1990 and 2000.

_____ Geothermal power
_____ Nuclear power
_____ Coal
_____ Natural gas
_____ Wind power
_____ Solar photovoltaics
_____ Hydroelectric power
_____ Oil

6. Complete the chart below filling in the characteristics of each broad category of nations as well their environmental challenges and concerns.

	Characteristics	Challenges and Concerns
Developed world		
Former Soviet bloc		
Newly industrializing countries		
Developing world		

Name:

Advanced Study Guide — Part II

The Environment and Economic Development

1. Why are most global environmental problems linked to energy use?

2. Summarize how people in the four major regions of the world view environmental problems.

Developed world:

Former Soviet bloc:

Newly industrializing countries:

The developing world:

Understanding the Carbon Cycle

Objectives:

Students will:

- Identify the key components of the global carbon cycle.
- Assess humanity's impact on the carbon cycle through an analysis of graphs and tables.
- Weigh the policy implications of humanity's contributions to increased concentrations of atmospheric carbon dioxide.

Required Reading:

Students should have read "Optional Reading: Following the Path of the Carbon Cycle" in the student text (pages 29-33) and completed the accompanying study guide (TRB-11).

Handouts:

- "Humanity's Impact on the Carbon Cycle" (TRB 12-13)

In the Classroom:

1. *Reviewing Scientific Concepts* — Call on students to identify the most important scientific concepts related to the carbon cycle. Ask them to summarize humankind's impact on the carbon cycle.

2. *Analyzing Data* — Distribute "Humanity's Impact on the Carbon Cycle" and review the five sets of data with the class. Call on students to answer the questions associated with each graph or table. How are the questions related to the scientific concepts raised in the optional reading? How does each data set translate into challenges for national governments worldwide? What is the significance of the U.S. contribution to the increase in anthropogenic (man-made) carbon dioxide emissions? What steps could the United States take to reduce our country's emissions?

3. *Policy Implications* — Ask students to imagine that they are participating in an international conference on climate change. Based on the data before them, what policy recommendations would they make? What additional data would be useful for developing policy? Which data would receive the most emphasis from representatives of developed countries? What about representatives of developing countries?

Homework:

Students should complete "Estimating Your Household's Carbon Dioxide Emissions" (TRB-14). Students can also identify other sources of carbon dioxide emissions, e.g., transportation of their food supply.

Students should also read Part III of the background reading in the student text (pages 13-19) and complete "Study Guide — Part III" (TRB 16-17) or "Advanced Study Guide — Part III" (TRB-18).

Name:

Study Guide

Optional Reading: Following the Path of the Carbon Cycle

1. How are the processes of photosynthesis and respiration related to the carbon cycle?

2. Why is the atmosphere considered the "buffer" of the carbon cycle?

3. How is the oceanic process of carbon dioxide absorption related to the expectation that atmospheric carbon dioxide concentrations will probably rise for at least two centuries?

4. Summarize humanity's impact on the carbon cycle.

   a. anthropogenic (man-made) carbon sources:

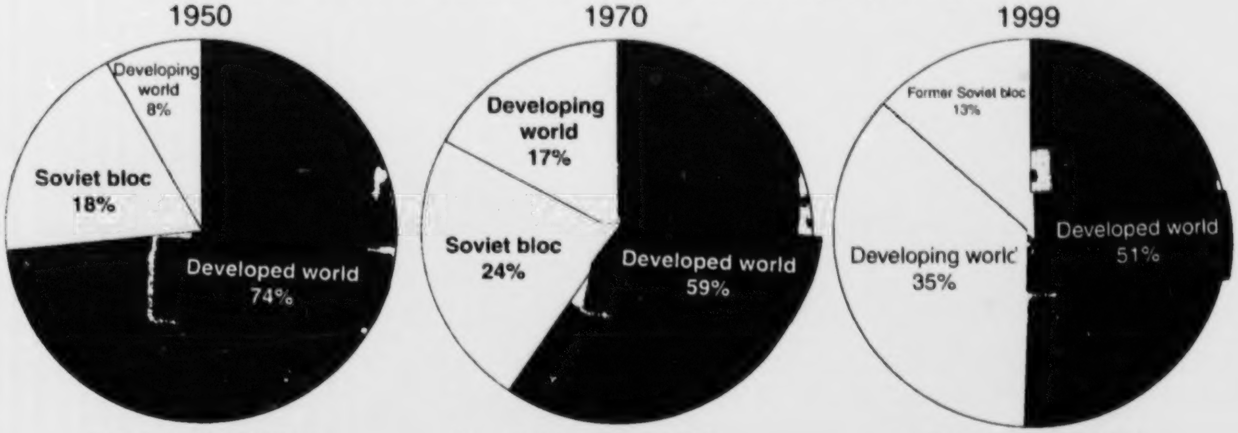
   b. anthropogenic (man-made) carbon sinks:

5. How does the current level of atmospheric carbon dioxide compare to past concentrations? How are scientists able to compare current carbon dioxide concentrations with past levels?

6. How would the "climate feedback" brought on by climate change likely affect the carbon cycle?

Humanity's Impact on the Carbon Cycle

Data Set #1: Carbon Dioxide Emissions by Region



Total: 1586 MtCs* Total: 3860 MtCs Total: 6438 MtCs

*1 MtC = 1 million tonnes, or one megaton, of carbon.

Although the developed world and the former Soviet bloc presently account for about two-thirds of global atmospheric carbon dioxide emissions, the share of the developing world has risen rapidly. What factors account for the changing proportions? What do you expect the balance to be in 2010?

Data Set #2: Carbon Dioxide Emissions by Source (measured in MtC/yr)

	Coal and other Solid Fuels	Oil and other Liquid Fuels	Natural Gas	Cement Production	Total
1860	93	0	0	No data	93
1880	224	3	0	No data	227
1900	505	16	4	No data	525
1920	870	76	13	No data	959
1940	1033	225	43	No data	1300
1960	1419	889	235	43	2586
1980	1950	2496	726	120	5292
1990	2393	2544	1004	157	6098
1999	2230	2704	1287	218	6438

Fossil fuels are responsible for about 80 percent of anthropogenic (man-made) carbon dioxide emissions. How has the balance of energy sources changed since 1860? How high will the atmospheric concentration of carbon dioxide climb if annual emissions rise by 2,000 MtCs in the next decade? How have scientists used carbon isotopes to determine that fossil fuels have led to a build-up in atmospheric carbon dioxide?

Data Sources: CDIAC, U.S. Department of Energy, *Trends '93: A Compendium of Data; Policy Implications of Greenhouse Warming;* and *Global Warming: The Greenpeace Report.*

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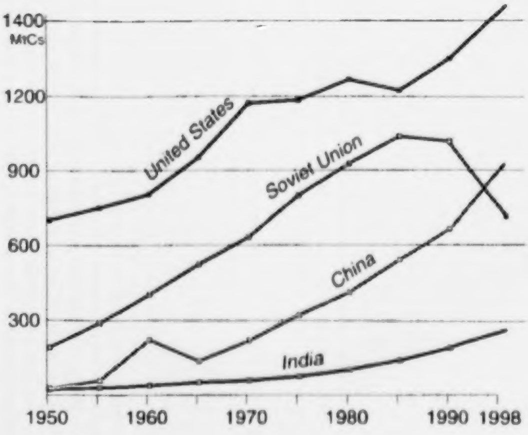
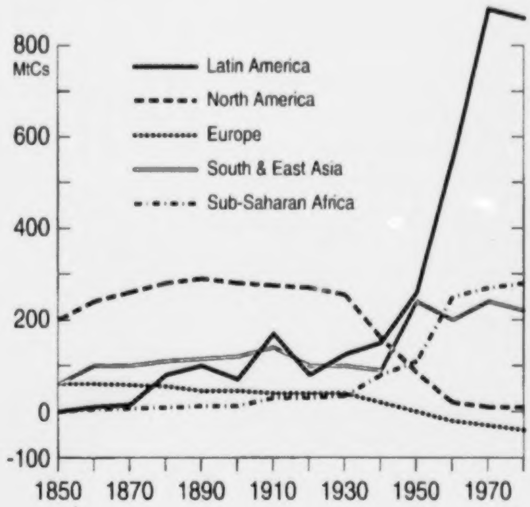


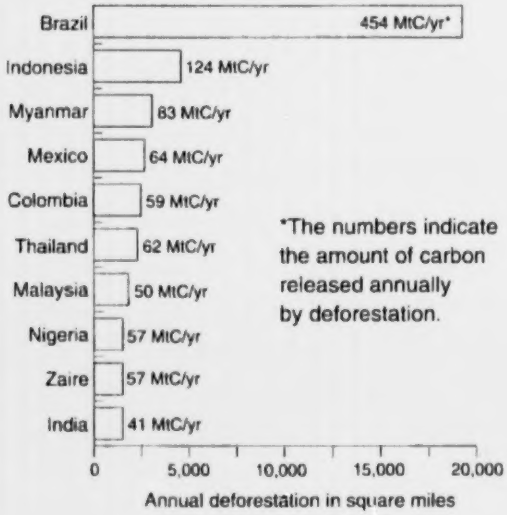
Data Set #3: Carbon Dioxide Emissions from Key Producers

The United States and the former Soviet Union were long the leading emitters of carbon dioxide, but since the collapse of the Soviet Union, China has moved ahead. Why will China's energy policy have a particularly significant impact on global atmospheric carbon dioxide concentrations in the future? Why has the United States failed to reduce its carbon dioxide emissions in recent years?

Data Set #4: Annual Net Carbon Emissions to the Atmosphere Due to Land Use Changes

Changes in land use, mostly in the developing world, account for about 20 percent of global atmospheric carbon dioxide emissions. Why are forests a vital sink of carbon dioxide? How have fossil fuel emissions possibly contributed to forest regrowth in the Northern Hemisphere? How would forests likely be affected by the climate feedback of climate change?





*The numbers indicate the amount of carbon released annually by deforestation.

Data Set #5: Leading Contributors to Deforestation and Carbon Release

Deforestation in the developing world is typically connected to population growth, the spread of agriculture, and industrial development. What are the factors contributing to deforestation in each of the ten countries featured in the graph? For example, what accounts for the differences in deforestation rates between Brazil and India? How do American consumers contribute to deforestation in the developing world?

Estimating Your Household's Carbon Dioxide Emissions

Using the following information, estimate your household's contribution to CO_2 emissions to the atmosphere. Be sure to use the same unit of time (week, month, day, etc.) for each of the calculations.

Automobile Burning a gallon of gasoline produces 9 kg of CO_2.

You will need the following information to calculate this portion of your CO_2 emissions:

a. miles driven
b. average miles per gallon for your household's car(s)

Sample calculation: If you drive 1,000 miles and your car averages 25 miles per gallon, your car will give off 360 kg of CO_2.

1000 miles * (1 gallon gas/ 25 miles) = 40 gallons of gas
40 gallons of gas * (9 kg CO_2/1 gallon of gas)= 360 kg CO_2

Electricity 1 kilowatt hour of electricity produces 1 kg of CO_2.

You will need the following information to calculate this portion of your CO_2 emissions:

kilowatt hours used (This can be obtained by reading a monthly electric bill, or reading an electric meter.).

Sample Calculation: If you used 280 kilowatts in a month, you will have contributed 280 kg of CO_2 to the atmosphere.

280 kilowatts * (1 kg CO_2 / kilowatt)=280 kg CO_2

Note: *One kilowatt of electricity produced by a coal-fired electrical plant. Approximately sixty-percent of electricity produced in the United States in January 2000 was produced using coal.*

Natural Gas Burning 100 cubic feet of natural gas produces 5.5 kg of CO_2.

You will need the following information to calculate this portion of your CO_2 emissions:

cubic feet used (this can be obtained by reading a monthly gas bill, or reading the gas meter)

Sample Calculation: If you use 3600 cubic feet of gas to heat your home or water you will have contributed 198kg of CO_2 to the atmosphere.

3600 cubic feet * (5.5 kg CO_2 / 100 cubic feet)=198 kg CO_2

Respiration A person exhales about 1 kg of CO_2 per day.

You will need the following information to calculate this portion of your CO_2 emissions:

a. numbers of household members
b. days in month

Sample Calculation: If you have four members in your household and there are 30 days in the month, your CO_2 emissions would be 120 kg of CO_2.

4 family members * (1 kg CO_2/ day) * (30 days)=120 kg CO_2.

Role Playing the Four Options: Organization and Preparation

Objectives:

Students will:

- Analyze the issues that frame the debate on U.S. global environmental policy.
- Identify the core underlying values of the options.
- Integrate the arguments and beliefs of the options and the background reading into a persuasive, coherent presentation.
- Work cooperatively within groups to organize effective presentations.

Required Reading:

Students should have read Part III of the background reading in the student text (pages 13-19) and completed "Study Guide — Part III" (TRB 16-17) or "Advanced Study Guide — Part III" (TRB-18).

Handouts:

- "Presenting Your Option" (TRB-19) for option groups
- "Expressing Key Values" (TRB-20) for option groups
- "Presidential Advisory Panel Members" (TRB-21) for panel members

In the Classroom:

1. *Planning for Group Work* — In order to save time in the classroom, form student groups before beginning Day Three. During the class period of Day Three, students will be preparing for the Day Four simulation. Remind them to incorporate the background reading into the development of their presentations and questions.

2a. *Option Groups* — Form four groups of four students. Assign an option to each group. Distribute "Presenting Your Option" and "Expressing Key Values" to the four option groups. Inform students that each option group will be called upon in Day Four to present the case for its assigned option to an advisory panel formed to counsel the president on U.S. policy toward global environmental problems. Explain that option groups should follow the instructions in "Presenting Your Option." Note that the option groups should begin by assigning each member a role.

2b. *Advisory Panel Members* — The remainder of the class will serve as members of the presidential advisory panel. Distribute "Presidential Advisory Panel Members" to each commission member. While the option groups are preparing their presentations, members of the advisory panel should develop cross-examination questions for Day Four. (See "Presidential Advisory Panel Members.") Remind panel members that they are expected to turn in their questions at the end of the simulation.

Suggestions:

In smaller classes, other teachers or administrators may be invited to serve as members of the advisory panel. In larger classes, additional roles — such as those of newspaper reporter or lobbyist — may be assigned to students.

Extra Challenge:

Ask the option groups to design a poster or a political cartoon illustrating the best case for their options.

Homework:

Students should complete preparations for the simulation.

Name: ____

Study Guide — Part III

Environmental Issues and the International Agenda

1. The North-South divide includes disagreement on environmental issues. The dispute is not about the importance of the earth's ecology, but ____.

2. What do developed nations believe are the chief threats to the world's environment?

    a.

    b.

3. Regarding threats to the environment, developing nations believe that:

    a.

    b.

    c.

4. List two international agreements reached at the Earth Summit.

    a.

    b.

5. How does the Kyoto Protocol differ from the Framework Convention on Climate Change that was signed at the Earth Summit?

Name: ____ Day 3

6. What are the United States' objections to the Kyoto Protocol? Explain.

7. What tactics does the U.S. advocate for improving the quality of the environment?

8. How have the successes in international cooperation on the environment occurred?

9. The United States consumes over _______ percent of the world's energy and produces _________ percent of the world's goods and services.

10. What is a carbon tax? What is the purpose of a high carbon tax?

11. What technological advances may help reduce automobile pollution?

Name:

Advanced Study Guide — Part III
Environmental Issues and the International Agenda

1. Summarize the positions of the developed and developing worlds regarding global environmental problems.

2. How did the North-South divide influence the agreements that came out of the Earth Summit?

3. What were the most controversial issues discussed at the Kyoto conference?

4. How are foreign aid and trade policy connected to international efforts to address global environmental problems?

5. In what respects does U.S. environmental policy differ from that of Western Europe and Japan?

6. Why are measures taken in the name of environmental protection often opposed by critics of big government?

Presenting Your Option

Preparing Your Presentation

Your Assignment: Your group has been called upon to appear before a panel that will advise the president on U.S. global environmental policy. Your assignment is to persuade panel members that your option should be the basis for U.S. policy. You will be judged on how well you present your option.

Organizing Your Group: Each member of your group will take a specific role. Below is a brief explanation of the responsibilities for each role.

1. *Spokesperson:* Your job is to explain the option of your group to the presidential advisory panel in a three-to-five minute presentation. In preparing your presentation, you will receive help from the other members of your group. You should include arguments from their areas of expertise. Keep in mind, though, that you are expected to take the lead in organizing your group. Read your option and review the background reading to build a strong case for your option. The "Expressing Key Values" worksheet will help you organize your thoughts.

2. *Environmental Scientist:* Your job is to advise the spokesperson of your group on why your option is scientifically sound. Carefully read your option, and then review Part I (pages 1-7) of the background reading and the sections about Resources in Part II (pages 8-10). Make sure that your area of expertise is reflected in the presentation of your group spokesperson. The "Expressing Key Values" worksheet will help you organize your thoughts.

3. *Domestic Policy Analyst:* Your job is to advise the spokesperson of your group on how the policies of your option would address problems here at home. You should concentrate on assessing the effects of your option on our country's environment and economy. Carefully read your option, and then review pages 16-19 of Part III of the background reading, beginning with "Determining U.S. Policy." Make sure that your area of expertise is reflected in the presentation of your group spokesperson. The "Expressing Key Values" worksheet will help you organize your thoughts.

4. *Foreign Policy Analyst:* Your job is to advise the spokesperson of your group on how your option would serve our country's foreign policy interests. Carefully read your option, and then review the "Local Perspectives" section of Part II (pages 10-12) of the background reading and Part III (pages 13-16) up to "Determining U.S. Policy." Make sure that your area of expertise is reflected in the presentation of your group spokesperson. The "Expressing Key Values" worksheet will help you organize your thoughts.

Making Your Case

After your preparations are completed, your spokesperson will deliver a three-to-five minute presentation to the presidential advisory panel. The "Expressing Key Values" worksheet and other notes may be used, but the spokesperson should speak clearly and convincingly. During the other presentations, you should try to identify the weak points of the competing options. After all of the groups have presented their options, members of the advisory panel will ask you cross-examination questions. Any member of your group may respond during the cross-examination period.

Name:

Expressing Key Values

The notion of values lies at the core of this unit. Each of the four options in this unit revolves around a distinct set of values. The opening two paragraphs of your option are devoted to making a convincing case for the values that are represented. The term "values," however, is not easy to define. Most often, we think of values in connection with our personal lives. Our attitudes toward our families, friends, and communities are a reflection of our personal values.

Values play a critical role in our civic life as well. In the United States, our country's political system and foreign policy have been shaped by a wide range of values. The high value many Americans place on freedom, democracy, and individual liberty rings loudly throughout U.S. history. For most of our country's existence, the impulse to spread American values beyond our borders was outweighed by the desire to remain independent of foreign entanglements. Since World War II, however, the United States has played a larger role in world affairs than any other nation. At times, American leaders have emphasized the values of international cooperation and shared responsibility. On other occasions, the values of independence and economic security have been stressed. Many of these values have entered into the debate on global environmental policy.

Some values fit together well. Others are in conflict. Americans are constantly being forced to choose among competing values in our ongoing discussion of public policy. Your job is to identify and explain the most important values underlying your option. These values should be clearly expressed by every member of your group. This worksheet will help you organize your thoughts.

1. What are the two most important values underlying your option?

   a.

   b.

2. According to the values of your option, what should be the role of the United States in the world?

3. Why should the values of your option serve as the basis for our country's global environmental policy?

Name:

Presidential Advisory Panel Members

Hearing on Global Environmental Policy

Your Role

You have been appointed to serve on a select panel that advises the president on global environmental policy. As you know, scientists in the past few decades have come to recognize that a new set of environmental concerns, including climate change and the depletion of the ozone layer, affect the entire planet. Increasingly, global environmental problems have entered the arena of international relations and have emerged as a subject of debate here at home. These hearings will introduce you to four distinct approaches for U.S. policy on this issue.

Your Assignment

While the four option groups are organizing their presentations, you should prepare two questions regarding each of the options. Your teacher will collect these questions at the end of Day Four.

Your questions should be challenging and critical. For example, a good question for Option 1 might be:

> *If the United States adopts Option 1, how would our relations with Western Europe and Japan be affected?*

On Day Four, the four option groups will present their positions. After the presentations are completed, your teacher will call on you and your fellow panel members to ask questions. The "Evaluation Form" you receive is designed for you to record your impressions of the option groups. Part I should be filled out in class after the option groups make their presentations. Part II should be completed as homework. After this activity is concluded, you may be called upon to explain your evaluation of the option groups.

Role Playing the Four Options: Debate and Discussion

Objectives:

Students will:

- Articulate the leading values that frame the debate on U.S. global environmental policy.
- Explore, debate, and evaluate multiple perspectives on U.S. global environmental policy.
- Sharpen rhetorical skills through debate and discussion.
- Cooperate with classmates in staging a persuasive presentation.

Handouts:

- "Evaluation Form" (TRB-23) for panel members

In the Classroom:

1. *Setting the Stage* — Organize the room so that the four option groups face a row of desks reserved for the presidential advisory panel. Distribute "Evaluation Form" to the advisory panel members. Instruct members of the panel to fill out the first part of their "Evaluation Form" during the course of the period. The second part of the worksheet should be completed as homework.

2. *Managing the Simulation* — Explain that the simulation will begin with three-to-five minute presentations by the spokespersons for the option groups. Encourage the spokespersons to speak clearly and convincingly.

3. *Guiding Discussion* — Following the presentations, invite members of the presidential advisory panel to ask cross-examination questions. Make sure that each panel member has an opportunity to ask at least one question. The questions should be evenly distributed among all four option groups. If time permits, encourage members of the option groups to challenge the positions of the other groups. During cross-examination, allow any option group member to respond. (As an alternative approach, permit cross-examination after the presentation of each option.)

Homework:

Students should read each of the four options in the student text (pages 21-28), then moving beyond these options they should fill out "Focusing Your Thoughts" (TRB-25), and complete "Your Option Five" (TRB-26).

Name: Day 4

Evaluation Form
Presidential Advisory Panel Members

Part I

What was the most persuasive argument presented in favor of this option?	What was the most persuasive argument presented against this option?
Option 1	*Option 1*
Option 2	*Option 2*
Option 3	*Option 3*
Option 4	*Option 4*

Part II

Which group presented its option most effectively? Explain your answer.

Looking into the Future

Objectives:

Students will:

- Articulate coherent recommendations for U.S. global environmental policy based on personally held values.
- Weigh the long-term consequences of individual policy recommendations.
- Integrate policy options and beliefs into a personalized letter.

Required Reading: Students should have read each of the four options in the student text (pages 21-28), and completed "Focusing Your Thoughts" (TRB-25) and "Your Option Five" (TRB-26).

In the Classroom: 1. *Expressing Values* — Call on members of the presidential advisory panel to share their evaluations of the option groups. Which arguments were most convincing? Which beliefs were most appealing? Review the beliefs in "Focusing Your Thoughts," noting the relationship between beliefs and options. Call on students to explain how their beliefs guided their responses in "Your Option Five."

2. *Considering the Kyoto Protocol* — Invite students to assess the Kyoto Protocol in the context of their options. How do their recommendations on U.S. greenhouse gas emissions compare to the targets of the Kyoto Protocol? What should be the role of the developing world in containing greenhouse gas emissions?

3. *Answering to the Next Generation* — Inform students that they will be using their responses to "Your Option Five" as the basis for writing a letter projected one generation into the future. Students should imagine that the recipients of the letters are their own teenage children. They should also assume that their children would share many of their own questions about environmental issues. The opening salutation should be addressed "Dear Son/Daughter." Instruct students to begin the letter by summarizing the beliefs and policies of their options. In the conclusion of their letter, they should explain how their proposed options will result in a better life for the next generation. If time permits, invite students to share their letters with the class.

Suggestions: Students may be given the choice of working individually or in pairs.

Extra Challenge: As homework, instruct students to write a letter based on their option to the editor of a local newspaper, a member of Congress, or the president. Suggest that students incorporate current issues into their letters.

Encourage students to explore the local dimension of global environmental issues. For example, how will U.S. efforts to reduce the emission of greenhouse gases and ozone-depleting chemicals affect the local environment and economy? Have local businesses developed new products and services to reduce pollution? Suggest that students contact organizations that have sought to make their voices heard in the debate on environmental issues. Many community-based environmental groups maintain ties to national advocacy organizations. Major corporations, especially those involved in the energy business, also are active in environmental issues.

Name: ____________________

Focusing Your Thoughts

Instructions: You have had an opportunity to consider four options on U.S. global environmental policy. Now it is your turn to look at each of the options from your own perspective. Try each one on for size. Think about how the options address your concerns and hopes. You will find that each has its own risks and trade-offs, advantages and disadvantages. After you complete this worksheet, you will be asked to develop your own option on this issue.

Ranking the Options

Which of the options below do you prefer? Rank the options, with "1" being the best option for the United States to follow.

___ **Option 1: Put the Economy First**

___ **Option 3: Promote Sustainable Development**

___ **Option 2: Take the Lead in the Green Economy**

___ **Option 4: Protect Mother Earth**

Beliefs

Considering the statements below will help you answer the first three questions of "Your Option Five." Rate each of them according to your personal beliefs:

1 = Strongly Support
2 = Support
3 = Oppose
4 = Strongly Oppose
5 = Undecided

___ To solve global problems, rich and poor countries must work together.

___ As the most powerful nation in the world, the United States is capable of addressing international problems without relying on other countries.

___ The United States should not allow other countries to shape policies that affect the lives of Americans.

___ Countries that are poor and technologically backward need to develop their own solutions.

___ The United States has a responsibility to share science and technology to help solve the most pressing problems in poor countries.

___ The health of the U.S. economy has a greater impact on the lives of Americans than any other issue.

___ The United States needs the help of Western Europe and Japan to deal with international problems.

___ Poverty, lack of development, and corruption have left many poor countries unable to cope with critical problems within their borders.

___ In our competitive world, the United States cannot afford to give up any advantage in science and technology.

___ Americans today need to make sacrifices in their way of life to safeguard the world for future generations.

Creating Your Own Option

Your next assignment is to create an option that reflects your own beliefs and opinions. You may borrow heavily from one option, or you may combine ideas from two or three options. Or you may take a new approach altogether. There are, of course, no perfect solutions. And there is no right or wrong answer. Rather, you should strive to craft an option that is logical and persuasive. Be careful of contradictions. For example, we should not offer to share our technology with other countries if our goal is to take the lead in industries that protect the environment.

Name: ________________________________

Your Option Five

Instructions: In this exercise, you will offer your own recommendations for U.S. global environmental policy. Your responses to "Focusing Your Thoughts" should help you identify the values of your proposal.

1. How important are environmental problems compared to other problems facing the United States?

2. Which parts of the world pose the greatest threat to the global environment?

3. What changes, if any, should the United States make in its relations with other countries in response to environmental problems?

4. Summarize the option you think the United States should adopt regarding global environmental policy.

5. What are the two strongest arguments opposing your option?

   a.

   b.

6. What are the two strongest arguments supporting your option?

   a.

   b.

Key Terms

Part I

economic development
ground water
ecosystem
industrial revolution
pollutants
fossil fuels
emissions
polar icecaps
productivity
industrialization
precipitation patterns
ultraviolet radiation
extinction
wetlands
developing countries
developed countries
resources
oil reserves
conservation
political clout
market
persistent organic pollutant
genetically modified food

Part II

consumption
population growth
renewable energy
livestock
smog
fuel-efficiency standards
Soviet bloc
photovoltaic cells
electrolysis
hydrogen fuel cells

Part III

international diplomacy
colonialism
tax incentives
sustainable development
inexpensive labor
political divisions
ratify
subsidies
tax credits
carbon sinks
forest management
emission rights
foreign aid
international trade
barrier to trade
international organizations

Global Environmental Problems
Issues Toolbox

United Nations Framework Convention on Climate Change (UNFCCC): This international agreement represents the starting point for the efforts to stabilize greenhouse gas concentrations in the atmosphere without harming food production or preventing sustainable development.

The precautionary principle: A guiding principle of the UNFCCC which states that the lack of certain scientific proof about climate change should not be used as a reason to delay acting when there is a threat of serious or irreversible damage.

Common but differentiated responsibilities: Another guiding principle of the UNFCCC which states that while both developed and developing nations have a responsibility for the environment, the wealthier, developed nations should take the lead in combating climate change.

Conference of the Parties (COP): This is the governing body of the UNFCCC. It is made of the more than 170 nations that have ratified the UNFCCC. The COP's function is to meet regularly and to oversee the implementation of the UNFCCC. The Kyoto Protocol was developed at one of these sessions.

Treaties, Conventions, Protocols: Treaties, conventions, and protocols are all types of international agreements. The U.S. President may sign any international agreement, but it does not become the law of the land until it is ratified by two-thirds of the Senate.

Non-governmental organizations (NGOs): NGOs are non-profit, private organizations with a particular interest in a public policy issue. Environmental NGOs attended the Earth Summit and continue to attend the COP to interact with government representatives and to provide information. NGOs not only lobby governments to achieve their goals, but more and more they fulfill the role of governments by pursuing their goals in the field. One example of an environmental NGO is The Nature Conservancy, well known for its work in purchasing and preserving land.

Biodiversity: Biodiversity, or biological diversity, refers to the range of all life on earth at all levels of classification — genes, populations, species, habitats, and ecosystems. The loss of biodiversity at any level impacts all other levels. Because the parts of this web are interconnected, as elements are removed, even human health could be affected.

Sustainable Development: The ability to meet the resource needs of the present generation without compromising those of future generations. Central to this concept is the prospect that ecosystems provide goods and services (food, fiber, water, flood protection, medicines, etc.) that sustain human populations. Such resources can be managed so as to ensure human well-being; yet maintained, renewed, and conserved so that future generations can similarly enjoy such resources. The term sustainable development is used to discuss a variety of guidelines or scenarios for promoting environmental health, economic growth, and cultural survival simultaneously. The World Summit in Johannesburg in 2002 reiterated the UN's dedication to sustainable development. Those who promote sustainable development often say that international cooperation and assistance to developing nations is crucial for success.

Making Choices Work in Your Classroom

Like the art of cooking, cooperative group learning is a skill that is rarely perfected on the first attempt, either by teachers or students. Yet with careful preparation, guidance, and practice significant gains can be made quickly. No single recipe guarantees success with cooperative learning or the Choices approach in every classroom. That would be impossible, since each classroom differs in its organization and size, and its unique collection of personalities and needs. However, this section of the Teacher Resource Book offers a variety of ingredients for teachers to use as they adapt Choices curricula to their classrooms. The suggested ingredients that follow have been drawn from educational research on student-centered instruction and, more important, from the experiences of teachers who have used Choices curricula successfully in their classrooms. Educators who have questions about using Choices curricula in their classrooms are encouraged to contact the Choices Program at choices@brown.edu or by calling (401)863-3155. The Choices staff includes experienced classroom teachers who will be pleased to speak with you.

Designing Cooperative Learning Groups

Group Size: The key to successful cooperative group work is having a group assignment that is complex enough to require the participation of all group members. Planning the size and composition of working groups in advance is crucial to the successful use of Choices curricula. Research indicates that the ideal size for a cooperative learning group is four or five students. This is certainly the ideal size for group assignments in Choices units. When using Choices units in larger classes, the size of option groups may be expanded to six or seven students. However, it is important to keep in mind that whenever the number of students in a group is increased, the number of roles and expected outcomes must also be expanded.

Group Composition: A strength of cooperative learning is that it creates opportunities for students to work together in new combinations on challenging tasks. Cooperative learning not only requires the academic skills of reading, writing, and critical thinking, but the interpersonal skills of communication, negotiation, and problem-solving. In most cases, this style of instruction and learning is most effective when students are assigned to groups by the teacher rather than being allowed to work with their friends. While random group selection can be effective, in most classes successful group composition requires that the teacher consider the personalities, strengths, and needs of the students.

Groups comprised of students with diverse strengths, talents, and needs are ideal. For example, artistic students might be assigned to different groups to share their talents and perspectives, while less verbal students could be placed in groups with more outgoing students to help draw them into the lesson. Whenever possible, teachers should try to prevent one student from dominating a group. Explaining the instructions, roles, and ground rules for cooperative learning (see below) helps prevent this. Teachers may choose to group aggressive students with each other, leaving room in other groups for less assertive students to emerge as leaders. Finally, even though the negotiation of roles among the students in a group can be a valuable part of the cooperative learning experience, teachers might choose to assign certain roles, such as group spokesperson, in order to encourage leadership from more reticent students and to keep more aggressive students from dominating.

Students may initially complain about being assigned to groups that do not include their closest friends. We have found that, at the conclusion of the assignment, they will usually express satisfaction with their assigned partners, recognize that they got more accomplished, and sometimes even acknowledge the start of new friendships. The additional time involved in planning group size and composition will pay off when students are actively engaged, debating, and thinking critically.

Preparing Students for Cooperative Learning

Provide Clear Written Instructions: As with any assignment, students benefit from instructions and guidelines that clearly outline expectations and how they will be accomplished. These should be given to students in writing and reviewed with the class. Afterwards, as questions arise within groups, students should refer to the written instructions and attempt to answer each other's questions before asking for the teacher's assistance.

Establish Ground Rules: Especially when cooperative learning is a new experience, students benefit from the establishment of ground rules that are explained before groups are formed. Ground rules must be kept simple, and should be designed to keep students involved and on task. Posting these rules in a prominent place in the classroom can be very effective. An example of simple but effective ground rules for the cooperative group assignments could be:

Everybody has a role (or a job)
Everybody participates
Nobody dominates
Nobody interrupts

These rules can be enforced by appointing one student to serve as the group manager. The teacher can make it clear that one of the group manager's responsibilities is to enforce the ground rules as the group explores its assigned option and prepares its presentation. The group manager might also be required to make sure that members of the group stay on task and attempt to solve problems before asking for the teacher's assistance. Ground rules that are clear and used consistently can, over time, become an integral component of the classroom, facilitating learning and keeping students on task.

Managing the Choices Simulation

Recognize Time Limitations: At the heart of the Choices approach is the role-play simulation in which students advocate different options, question each other, and debate. Just as thoughtful preparation is necessary to set the stage for cooperative group learning, careful planning for the presentations and debate can increase the effectiveness of the simulation. Time is the essential ingredient to keep in mind. A minimum of 45 to 50 minutes is necessary for the presentations and debate. Hence, if only one class period is available, student groups must be ready as soon as class begins. Teachers who have been able to schedule a double period or extend the length of class to one hour report that the extra time is beneficial. When necessary, the role-play simulation can be run over two days, but this disrupts the momentum of the debate. The best strategy for managing the role-play is to establish and enforce strict time limits, such as five minutes for each option presentation, ten minutes for questions and challenges, and the final five minutes of class for wrapping up the debate. It is crucial to make students aware of strict time limits as they prepare their presentations.

Highlight the Importance of Values: During the debate and debriefing, it is important to highlight the role of values in the options. Students should be instructed to identify the core values and priorities underlying the different options.

Moving Beyond the Options

As a culminating activity of a Choices unit, students are expected to articulate their own views of the issue under consideration. An effective way to move beyond the options debate to creating individual options is to have students consider which values in the options framework they hold most dear. Typically, students will hold several of these values simultaneously and will need to prioritize them to reach a considered judgment about the issue at hand. These values should be reflected in their own options and should shape the goals and policies they advocate.

Adjusting for Large and Small Classes

Choices units are designed for an average class of twenty-five students. In larger classes, additional roles, such as those of newspaper reporter or member of a special interest group, can be assigned to increase student participation in the simulation. With larger option groups, additional tasks might be to create a poster, political cartoon, or public service announcement that represents the viewpoint of an option. In smaller classes, the teacher can serve as the moderator of the debate, and administrators, parents, or faculty can be invited to play the roles of congressional leaders. Another alternative is to combine two small classes.

Assessing Student Achievement

Grading Group Assignments: Research suggests that it is counterproductive to give students individual grades on cooperative group assignments. A significant part of the assignment given to the group is to cooperate in achieving a common goal, as opposed to looking out for individual interests. Telling students in advance that the group will receive one grade often motivates group members to hold each other accountable. This can foster group cohesion and lead to better group results. It may be useful to note that in addition to the cooperative group assignments, students complete individual assignments as well in every Choices unit. The "Assessment Guide for Oral Presentations" on the following page is designed to help teachers evaluate group presentations.

Requiring Self-Evaluation: Having students complete self-evaluations is an extremely effective way to make them think about their own learning. Self-evaluations can take many forms and are useful in a variety of circumstances. They are particularly helpful in getting students to think constructively about group collaboration. In developing a self-evaluation tool for students, teachers need to pose clear and direct questions to students. Two key benefits of student self-evaluation are that it involves students in the assessment process, and that it provides teachers with valuable insights into the contributions of individual students and the dynamics of different groups. These insights can help teachers to organize groups for future cooperative assignments.

Evaluating Student Options: The most important outcomes of a Choices unit are the original options developed and articulated by each student. These will differ significantly from one another, as students identify different values and priorities that shape their viewpoints. These options cannot be graded as right or wrong, but should be evaluated on clarity of expression, logic, and thoroughness. Did the student provide reasons for his/her viewpoint along with supporting evidence? Were the values clear and consistent throughout the option? Did the student identify the risks involved? Did the student present his/her option in a convincing manner?

Testing: In a formal evaluation of the Choices approach, it was demonstrated that students using Choices learned the factual information presented as well as or better than students who were taught in a more traditional lecture-discussion format. However, the larger benefits of the Choices approach were evident when students using Choices demonstrated significantly higher ability to think critically, analyze multiple perspectives, and articulate original viewpoints, compared to students who did not use this approach. Teachers should hold students accountable for learning historical information, concepts, and current events presented in Choices units. However, a simple multiple-choice examination will not allow students to demonstrate the critical thinking and communication skills developed through the Choices unit. If teachers choose to test students, they may wish to explore new models of test design that require students to do more than recognize correct answers. Tests should not replace the development of student options.

For Further Reading: Cohen, Elizabeth G. *Designing Groupwork: Strategies for the Heterogeneous Classroom* (New York: Teachers College Press, 1986).

Assessment Guide for Oral Presentations

Group assignment: ______________________________

Group members: ______________________________

____

Group Assessment	*Excellent*	*Good*	*Average*	*Needs Improvement*	*Unsatisfactor*
1. The group made good use of its preparation time	5	4	3	2	1
2. The presentation reflected analysis of the issues under consideration	5	4	3	2	1
3. The presentation was coherent and persuasive	5	4	3	2	1
4. The group incorporated relevant sections of the background reading into its presentation	5	4	3	2	1
5. The group's presenters spoke clearly, maintained eye contact, and made an effort to hold the attention of their audience	5	4	3	2	1
6. The presentation incorporated contributions from all the members of the group	5	4	3	2	1
Individual Assessment					
1. The student cooperated with other group members	5	4	3	2	1
2. The student was well-prepared to meet his or her responsibilities	5	4	3	2	1
3. The student made a significant contribution to the group's presentation	5	4	3	2	1

Alternative Three-Day Lesson Plan

Day 1: See Day One of the Suggested Five-Day Lesson Plan. (Before beginning the unit, students should read Part I of the background reading and complete "Study Guide — Part I.")
Homework: Students should read Part II of the background reading and complete the second part of "Study Guide — Part II."

Day 2: Assign each student one of the four options, and allow a few minutes for students to familiarize themselves with the mindsets of the options. Call on students to evaluate the benefits and trade-offs of their assigned options. How do the options differ in their assumptions about the relative importance of global environmental problems? How would the U.S. role in the world change according to the recommendations of the options? Moving beyond the options, ask students to imagine that they have been called upon to advise the president on U.S. global environmental policy. What concerns would be at the top of their agenda? Which values should guide the direction of U.S. global environmental policy?
Homework: Students should complete "Focusing Your Thoughts" and "Your Option Five."

Day 3: See Day Five of the Suggested Five-Day Lesson Plan.

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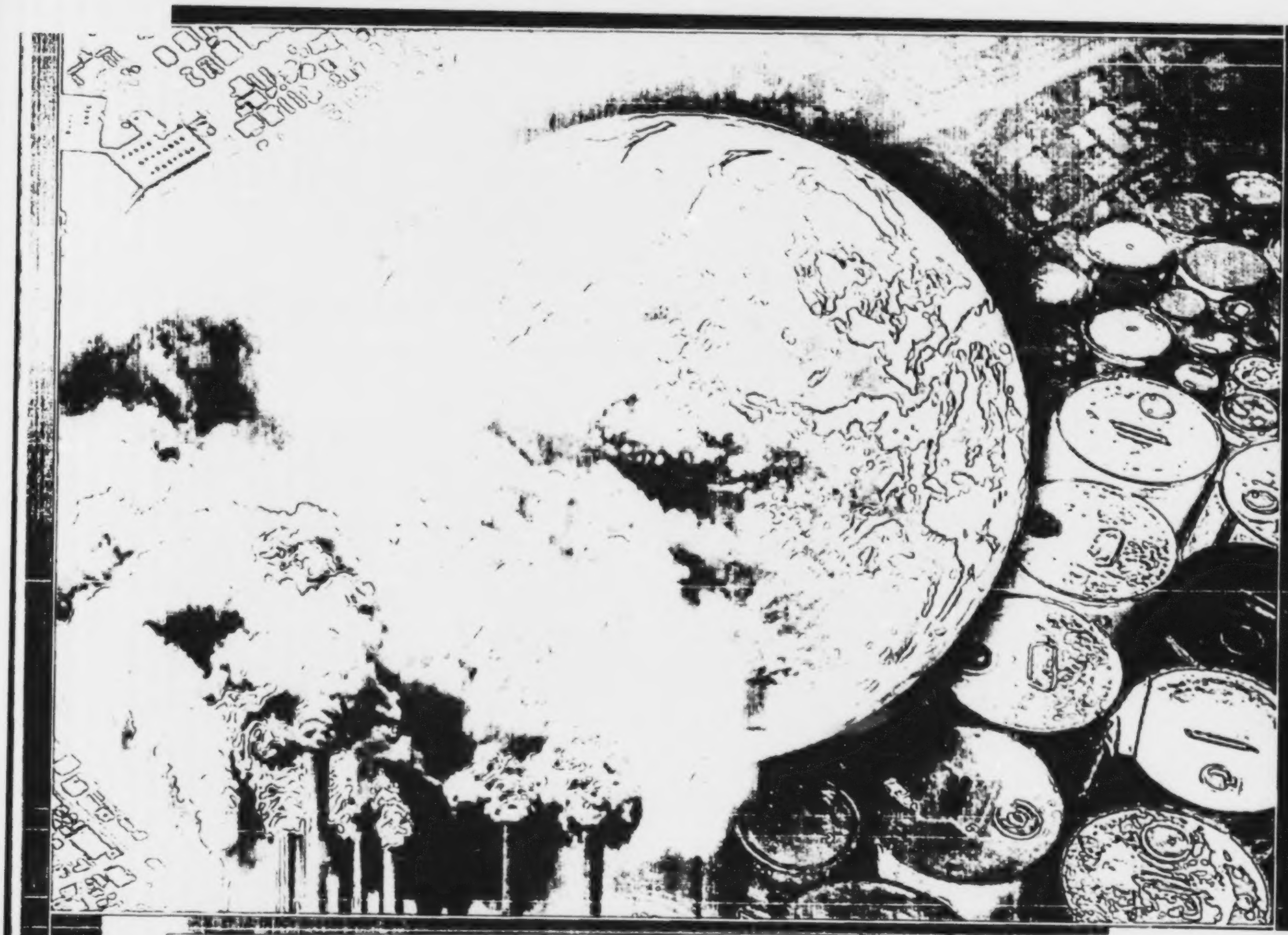

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ACKNOWLEDGMENTS

Global Environmental Problems: Implications for U.S. Policy was developed by the Choices for the 21st Century Education Program staff with the assistance of the research staff of the Watson Institute for International Studies, scholars at Brown University, and several other experts in the field. We wish to thank the following researchers for their invaluable input:

Robert Chen, *former Assistant Professor, World Hunger Program, Brown University*

Jarat Chopra, *Research Associate, Watson Institute for International Studies, Brown University*

Hilary F. French, *Senior Researcher, Worldwatch Institute*

Theodore D. Goldfarb, *Professor, Department of Chemistry, State University of New York at Stony Brook*

Steven Hamburg, *Director, Global Environment Program, Watson Institute for International Studies; Associate Professor, Center for Environmental Studies, Brown University*

Robert Kates, *former Professor, World Hunger Program, Brown University*

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Stephen Shenfield, *former Assistant Professor (Research), Watson Institute for International Studies, Brown University*

Sir Crispin Tickell, *Chancellor, University of Kent at Canterbury, UK*

Harold Ward, *former Director, Center for Environmental Studies, Brown University*

Richard Wetzler, *Associate Professor (Research), Watson Institute for International Studies, Brown University*

We wish to thank the following organizations: the American Enterprise Institute, the American Petroleum Institute, the Atomic Energy Commission, the Environmental Defense Fund, Greenpeace, the Heritage Foundation, the Natural Resources Defense Council, the Rainforest Action Network, the Rainforest Alliance, the United Nations Conference on Environment and Development, the United Nations Environment Programme, the U.S. Citizens Network on UNCED, the U.S. Department of State, the Worldwatch Institute, the World Bank, and the World Resources Institute.

Special thanks to the high school teachers who tested drafts of this material in their classrooms prior to publication: Don Bakker of North Eastham, Massachusetts; Candace Fisk of Springfield, Missouri; Marilyn Gallagher of Yonkers, New York; and Mick Hale of Omaha, Nebraska. Thanks also to David Magnussen and Jed Fitzgerald of Cohasset, Massachusetts, and to Margorie Porter of Woodstock, Connecticut, for their contributions to the development and review of material for inclusion in environmental science courses. We also wish to thank Karl Berger and Erik Bleich for their helpful contributions to an earlier edition of this unit.

We thank Michael Barton of Massachusetts, Patricia Clancy of New Jersey, and Ron Levitsky of Illinois for helping us to revise the format of Choices units to make them responsive to a wider variety of student learning styles.

Global Environmental Problems: Implications for U.S. Policy is part of a continuing series on public policy issues. New units are published each academic year, and all units are updated regularly.

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Thomas J. Biersteker
Director, Watson Institute for International Studies

CONTENTS

Part I: Global Environmental Problems 1

Part II: The Environment and Economic Development 8

Part III: Environmental Issues and the International Agenda 13

Options in Brief 20

Options 21-28

- **Option 1: Put the Economy First** 21
- **Option 2: Take the Lead in the Green Economy** 23
- **Option 3: Promote Sustainable Development** 25
- **Option 4: Protect Mother Earth** 27

Optional Reading: Following the Path of the Carbon Cycle 29

Supplementary Documents 34

Supplementary Resources 37

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Part I: Global Environmental Problems

A bustling steel mill in South Korea... farmland newly cleared from the jungle in Brazil... a computer assembly plant in the United States. Together, these images paint a picture of economic development and technological progress.

But look again. The advances that have brought new prosperity to much of the globe have come at a price. The smokestacks of the steel mill spew out pollutants that spread to other countries. The farm has been carved out of a rainforest that had served as a home for thousands of plants and animals. The computer plant relies on chemical cleaning agents that threaten ground water quality.

In making use of the earth's resources, humanity has assumed a greater and greater role in shaping the planet's environment. We have also come to recognize that the continued expansion of human activity has spawned a new set of problems that extends beyond national borders. While scientists note that the earth tends to be resilient and to bounce back from some of the stresses it takes, the magnitude of humanity's impact is taking its toll.

In this unit, you will weigh the choices and trade-offs involved in protecting the environment. The first section of the background reading has been designed to introduce you to the most significant global environmental problems, while Part II and Part III explore the economic and political dimensions of the environmental challenges facing our planet.

CLIMATE CHANGE & OZONE DEPLETION

Much of the current anxiety regarding environmental problems revolves around climate change and ozone depletion.

What is climate change?

Scientists believe that a changing climate is at least in part the result of human activities over the last two hundred years. The build-up of carbon dioxide, methane, nitrous oxide, and other gases in the atmosphere has warmed the earth, contributing to a rise in sea level, and a changing pattern of precipitation among other changes. These gases, which make up only a small percentage of the atmosphere, are called greenhouse gases because they trap heat in the atmosphere by absorbing much of the earth's infrared (long-wave) energy that would otherwise be radiated back into space. The process works the same way that a greenhouse prevents heat from escaping beyond its glass panels. Without greenhouse gases, the earth's temperature would be roughly fifty degrees (Fahrenheit) colder.

Carbon dioxide accounts for 60 percent of the greenhouse gas build-up attributable to human activity. Carbon dioxide is essential for life on earth. Plants require it just as animals need oxygen.

Humanity has added carbon dioxide to the atmosphere by burning fossil fuels such as oil, coal, and natural gas. Fossil fuels were formed from plants and animals that lived millions of years ago. In ages past, this organic matter accumulated under the earth's crust and was transformed into petroleum and natural gas by intense heat and pressure. Since the start of the Industrial Revolution in the late eighteenth century, the use of fossil fuels has soared and the amount of carbon dioxide in the atmosphere has increased by almost 30 percent.

What are the effects of climate change?

An international panel of twenty-five hundred scientists assembled by the United Nations (UN) concluded that industrialization is most likely responsible for at least part of the approximately one degree Celsius increase in the average global surface temperature over the past century. The panel predicted that average global temperatures would rise between 1.8 and 6.3 degrees Celsius by 2100 unless greenhouse gas emissions are curbed. If the projections prove correct, people in the next century will have to cope with an increased frequency of heat waves, floods, and droughts. Climate change would make temperatures around the world more extreme more often, broaden the range of some diseases and pest insects, and wipe out vast swaths of forest.

Moreover, the UN panel forecasts that climate change over the next hundred years could raise the level of the world's seas by about twenty inches as the polar icecaps melt. Nearly 20 percent of the world's population, as well as many of the planet's most fragile ecosystems, could become more vulnerable to coastal flooding. Recently, large-scale loss of coral reefs has been attributed to ocean warming.

Scientists acknowledge that they have much to learn about the factors affecting the global climate, and that the computer models they use to predict future global temperature and precipitation patterns need refinement. Not all scientists agree on the current effects of climate change.

What is ozone depletion?

Since the 1970s, scientists have known that certain chemicals damage the ozone layer — a layer in the stratosphere ten to twenty-five miles above the earth. This layer prevents much of the sun's damaging ultraviolet (UV) radiation from reaching the surface of the planet. (In contrast, ozone in the lower atmosphere is a polluting greenhouse gas.)

In 1985, scientists discovered a hole in the ozone layer over Antarctica the size of the continental United States. (The spring climate over the South Pole creates conditions that promote ozone destruction. Later in the year, the air from the Antarctic ozone hole drifts northward and contributes to a thinning of the global ozone layer.)

By late 1999, the area covered by the hole had more than doubled. Equally alarming, scientists have found a smaller hole in the ozone layer over the North Pole, leaving people in Canada and the northernmost areas of United States and Eurasia vulnerable to increased ultraviolet radiation. If human beings are exposed to higher levels of UV radiation, increased rates of skin cancer, cataracts, and immune

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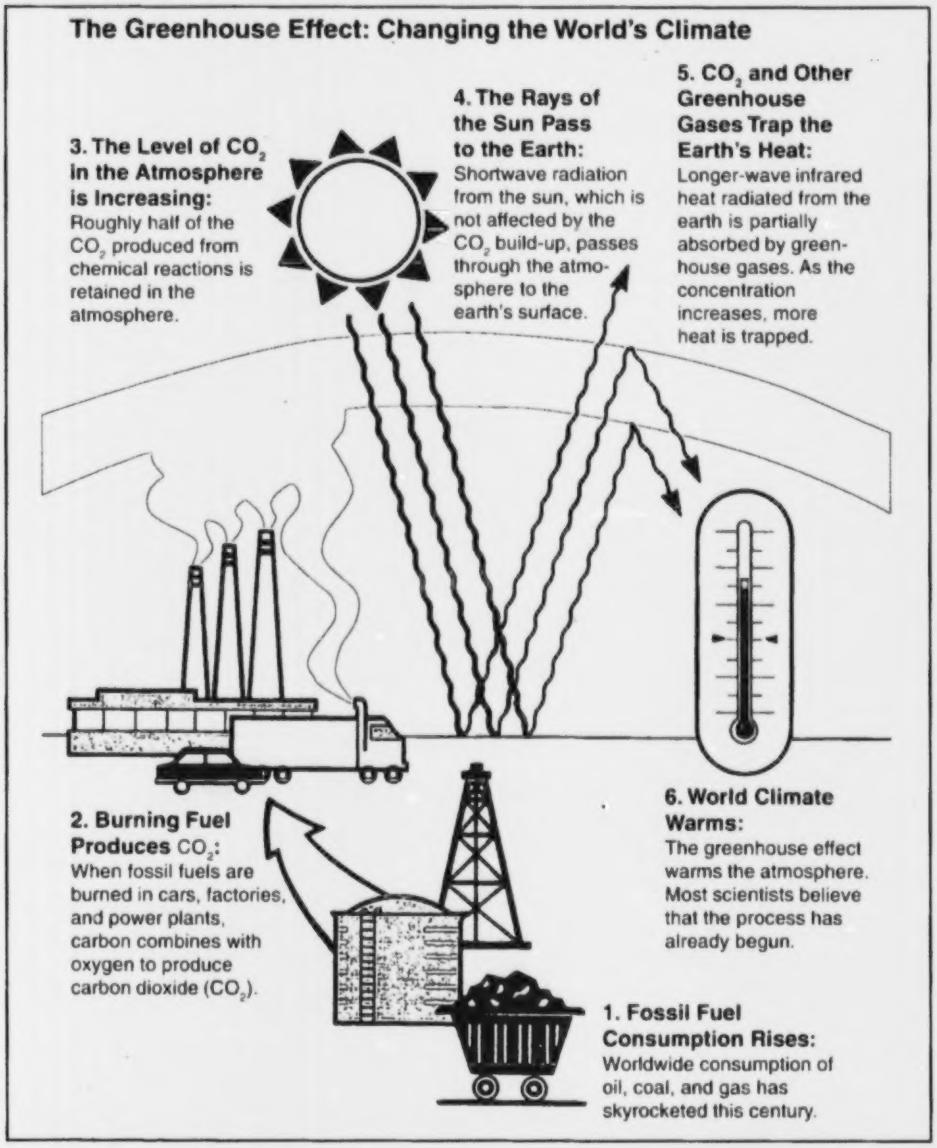

The Greenhouse Effect: Changing the World's Climate
3. The Level of CO_2 in the Atmosphere is Increasing: Roughly half of the CO_2 produced from chemical reactions is retained in the atmosphere.
4. The Rays of the Sun Pass to the Earth: Shortwave radiation from the sun, which is not affected by the CO_2 build-up, passes through the atmosphere to the earth's surface.
5. CO_2 and Other Greenhouse Gases Trap the Earth's Heat: Longer-wave infrared heat radiated from the earth is partially absorbed by greenhouse gases. As the concentration increases, more heat is trapped.
2. Burning Fuel Produces CO_2: When fossil fuels are burned in cars, factories, and power plants, carbon combines with oxygen to produce carbon dioxide (CO_2).
6. World Climate Warms: The greenhouse effect warms the atmosphere. Most scientists believe that the process has already begun.
1. Fossil Fuel Consumption Rises: Worldwide consumption of oil, coal, and gas has skyrocketed this century.

This chart shows the impact of fossil fuel use on climate change. Deforestation and land-use changes also contribute up to 25 percent of CO_2 emissions into the atmosphere.

system problems could be expected to result. Scientists predict that additional UV radiation could reduce crop yields and harm phytoplankton, the first link in the aquatic food chain.

What causes ozone depletion?

Chemicals containing chlorine and bromine have been linked to the destruction of the ozone layer. When these chemicals are released into the atmosphere, they slowly rise into the stratosphere and cause the destruction of ozone molecules for about 100 years. Of the chlorine-producing chemicals, chlorofluorocarbons (CFCs) have the greatest impact. They have been used in refrigeration, air conditioners, aerosols, upholstery, foam insulation, and packing materials. (They also contribute to climate change.) When CFCs were invented in 1928, they were hailed as a safe alternative to ammonia and other dangerous coolants used in refrigerators. No one imagined that these same chemicals posed an environmental threat. In 1987, however, developed countries agreed to stop producing CFCs. Developing countries have been called upon to stop production of CFCs by 2010. The ban on ozone-reducing chemicals has caused scientists to conclude that, if trends continue, the ozone layer will recover almost completely by about 2050.

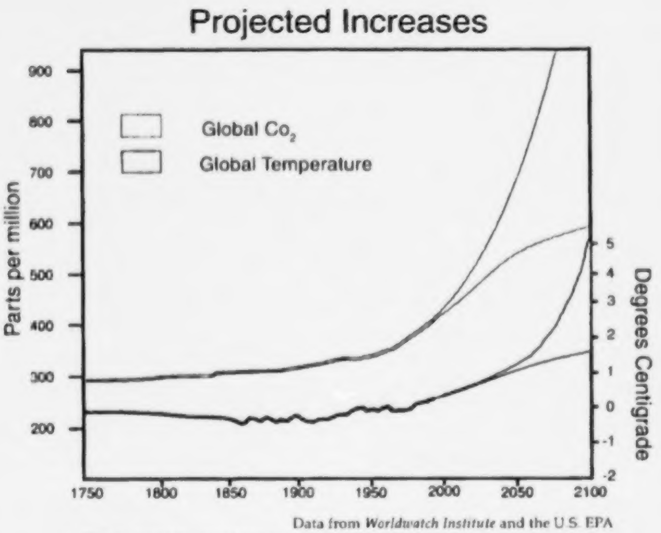
WATER POLLUTION

Climate change and ozone depletion are partly the result of pollutants released into the air by human activity. These and other pollutants are also responsible for contaminating water supplies.

What is acid rain?

Acid rain results from the nitrogen and sulfur emitted through the burning of fossil fuels, especially from power plants, manufacturers, and the transportation sector. Once in the atmosphere, the nitrogen and sulfur emitted are converted to acids which return to the earth's surface in rain, snow, or fog, often hundreds and thousands of miles from their source.

Scientists have determined that acid rain takes a heavy toll on lakes and forests. Excess acids leach nutrients from trees. The damage to the trees often appears as discolored leaves and needles. In some lakes and streams, acid rain has eliminated fish and amphibian populations.



Data from *Worldwatch Institute* and the U.S. EPA

This graph explains scenarios for global temperature and CO_2 presence depending on the possible changes to greenhouse gas emissions. If emissions continue to grow, the increases will be greater, and vice-versa.

What makes acid rain an international issue?

Acid rain has emerged as a international problem because air pollution moves among countries. This issue has been of particular concern in North America, Europe and East Asia. Germans, who decry the destruction of much of their famous Black Forest, claim that more than half of their acid rain originates elsewhere. Likewise, Canadians point out that the amount of acid rain they receive from the United States is up to four times more than the amount that the United States receives from Canada. Recently, the two neighbors agreed to stricter measures to reduce sulfur oxide emissions.

Concern about the impact of acid rain and pollution on human health has led many industrialized countries to control sulfur and nitrogen oxide pollution by promoting the use of scrubbers in coal plants and other technologies. In the developing world, however, increased industrialization and motor vehicle use threaten to extend the problem of acid rain to even more areas of the globe. Other water pollution problems also concern scientists.

How is drinking water affected by pollution?

The use of pesticides and other chemicals, such as by-products of combustion, harms the growth and health of plants and animals, particularly in predators at the higher level of the food chain. These compounds are called persistent organic pollutants or POPs. Although many nations have banned the use of the most harmful pesticides such as DDT, others still use them regularly. Even in countries where the toxic chemicals are no longer used, the ecosystem is still threatened because these compounds persist in the environment for decades.

About one-fifth of people world-wide do not have access to safe drinking water, either because of toxins which harm the supply, untreated sewerage which causes disease, or shortages which are sometimes caused by inefficient irrigation techniques. Approximately five million people die every year from contaminated water, almost entirely in poor countries.

What problems exist for oceans?

Ocean waters suffer from some of the same pollutants as fresh water, but are also exposed to oil spills and changes in current patterns which are the result of increasing temperatures. As ocean currents change, global weather patterns could shift and marine wildlife could suffer, notably in the form of decreasing coral reefs. Reefs provide the foundation for marine life and are the home for thousands of species.

Scientists are also concerned about red tide in coastal areas, which refers to a "bloom," or sudden increase in density and area, in a harmful algae which can be colored red. When fish and shellfish consume this toxic algae they can die. Other animals, including humans, can also die from eating contaminated fish. Scientists do not know what causes red tide, but some speculate that increased ocean temperatures or pollution could be a culprit.

DEFORESTATION

Since ancient times, people have cleared trees for agriculture and shelter. The great civilizations of the Mediterranean world devastated the woodlands of the region. The forests of Britain have shrunk to one-tenth of their original size over the past three thousand years.

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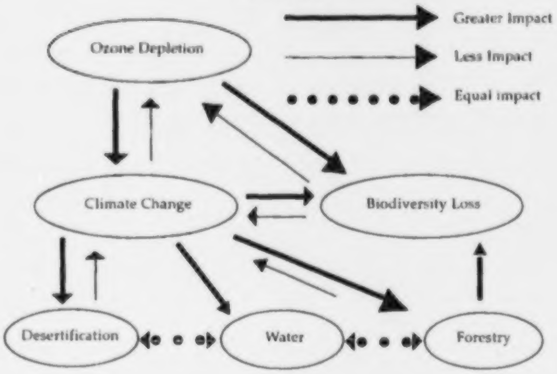
Linkages among Environmental Issues



While forests have actually expanded greatly in Europe and North America over the past century, the problem of deforestation has worsened in most developing countries. In areas where rainfall is scarce — amounting to one-third of the earth's land — the clearing of forests and expansion of agricultural areas often leads to the encroachment of desert.

What strains do deforestation and desertification put on the environment?

Deforestation and desertification are closely linked. The maintenance of vegetative cover holds soil in place and helps maintain sustainable nutrient cycles. When trees are chopped down, the soil is exposed to the full force of rain and wind, increasing rates of erosion. Poor farming practices and short-sighted irrigation projects can further increase soil erosion. Too many cattle on grazing lands can reduce vegetation, with resulting erosion and land degradation.

Every year, approximately seventy thousand square miles of land are taken out of agricultural production, at least temporarily, because of desertification. In the 1930s, grasslands in the western areas of the American Great Plains that had been plowed during the previous decade were turned into a dust bowl by drought. Regular rainfall and more careful farming

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practices eventually helped restore the productivity of much of the area. Today, agricultural land is being lost to desert primarily in Africa, where about one-quarter of the continent has undergone some form of desertification.

Many topical forests are also vulnerable to desertification. In Brazil, which contains 26 percent of the world's tropical forests, there has been continuing socio-economic pressure to convert forests in the Amazon River basin for use in cattle ranching, agriculture, and timber and paper production. Without a protective canopy of dense vegetation, however, tropical soils erode from the impacts of heavy rains, wind, and the drying effects of the equatorial sun.

The loss of tropical forests will speed up the pace of climate change. As living ecosystems, forests absorb carbon dioxide. When burned, however, they release the carbon dioxide they stored back into the atmosphere, contributing to the build-up of greenhouse gases.

BIODIVERSITY

As humanity has moved into areas that were once wilderness and introduced foreign species to places they never existed before, the rate of extinction of plants and animals has increased rapidly. Some biologists predict that the earth may lose one-fifth of the existing species in the next twenty years. Any loss of biodiversity — the range of life on the planet — is beyond human power to replace. Potential sources for new medicines, foods, and technologies are also lost, and ecosystem health may be compromised.

Where are preservation efforts most critical?

Concern for biodiversity centers on areas that are rich in plants and animals, such as tropical rainforests. Although they cover only 6 percent of the earth's land, tropical rainforests contain over half the world's land-dwelling species. Every year, more than forty million acres of tropical rainforest — an area the size of Washington state — are deforested, and with them four to six thousand tropical species are believed to go extinct. Other species-rich habitats are also endangered. Coastal wetlands and coral reefs have been damaged by development and changing patterns of use , while overfishing has nearly exhausted many of the ocean's most prized fishing grounds.

What measures have been taken to preserve biodiversity?

Beginning in the 1970s, the United States and other developed countries took the lead in adopting laws to protect endangered species. The Alaska National Interest Lands Conservation Act of 1980 set aside an area larger than California to preserve Arctic habitat. Safeguarding threatened and endangered species, however, has sparked protest from natural resource industries, such as timber and energy, which are barred from most protected areas.

Many developing countries have begun to protect threatened and endangered species by

Protected Areas and Threatened Species (2002)

Country	Land in Protected Areas (million hectares)	Share of Land Area Protected (percent)	Threatened Plants	Threatened Animals
United States	162	17	169	831
Russia	58	3	7	132
Japan	2.5	7	11	150
Germany	11	31	53	12
China	68	7	168	221
India	15	4.5	244	220
Indonesia	32	17	384	388
Brazil	48	6	381	274

Data from UNEP and the Union for Conservation of Nature and Natural Resources expanding their parks and preserves, particularly in areas that contain animals popular with tourists. Kenya, Botswana, and other African countries, for example, have imposed strict laws to protect wildlife. Throughout the developing world, however, governments often lack the funds to combat well-organized poaching or illegal timber harvesting operations.

What is biosafety?

A recent debate connected to biodiversity concerns the issue of biosafety and genetically modified organisms, including food crops and fish. These products, like corn and soybeans, are altered so as to resist disease and insects so that pesticides are less necessary, and to survive in harsher conditions. "Golden rice," which is a modified form of rice that includes more vitamins in order to combat malnutrition, is targeted for distribution in some poverty-stricken areas, but not without controversy.

Genetically modified (GM) grains began entering the U.S. food supply around 1996 and can now be found in small percentages in about 60 to 70 percent of packaged foods in the United States. It is not clear what the long-term impact, if any, of GM food is on the human body, but some scientists have voiced concern about potential impacts on immune systems. The European Union has imposed strict measures against the importation of GM foods.

A Kenyan scientist, Dr. Florence Wambugu, has initiated a project to develop genetically modified sweet potatoes, a high-vitamin and energy-providing crop that is resistant to disease. Her project, supported

Glossary of Environmental Terms

Greenhouse gases: Gases — such as carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons — that keep the earth's heat from escaping through the atmosphere.

Carbon dioxide (CO_2): A greenhouse gas which helps maintain the warmth of the planet by trapping infrared radiation. Since the Industrial Revolution, the amount of CO_2 in the atmosphere has risen by nearly 30 percent.

Fossil fuels: Oil, coal, and natural gas that were formed from plants and animals that lived millions of years ago. Fossil fuels supply about 90 percent of the world's energy.

Ozone layer: A shield of ozone (O_3) molecules 10-25 miles above the earth that blocks much of the sun's harmful ultraviolet radiation.

Chlorofluorocarbons (CFCs): Man-made chemical compounds used in refrigeration, insulation, foams, and a number of industrial processes. When CFCs reach the stratosphere, they release chlorine atoms that damage the ozone layer.

Sulfur oxides (SO_x) and nitrogen oxides (NO_x): The leading agents of acid rain. They are released through the burning of fossil fuels and organic matter.

Tropical forests: The band of dense vegetation covering much of the equatorial region that is home to more than half the world's land-dwelling plant and animal species. Cleared of tree cover, the thin soils of tropical forests are vulnerable to erosion caused by the heavy rainfall and intense sun of the tropics.

Endangered species: Species of plants and animals that face extinction because of human activity. Under the Endangered Species Act, plants and animals in the United States under threat are identified and protected.

Methane (CH_4): Also known as natural gas, methane is produced through bacterial activity in rice paddies and in the digestive tracts of cud-chewing animals, such as cows, and certain insects. CH_4 is twenty-five times more effective at trapping heat in the atmosphere than CO_2.

Biosafety: Addresses the potential harm from the handling and use of all GMOs and GM products to biological diversity, human health, and socio-economic patterns as a result of GMO dispersal, reproduction, and persistence in the environment.

Environmental equity: Fair and impartial access to clean air, water, and soil regardless of economic or social status.

by multinational biotech firms, estimates significant increases in production, farmer income, and food security if it is fully adopted in Kenya. The project also seeks to help create an arena for discussion of food safety regulations in countries which do not have extensive monitoring systems.

Critics of the sweet potato project suggest that the influence of multinational companies amounts to a new kind of colonialism and exposes African countries to dependence on outsiders. Supporters contend that Africans should be allowed to make their own decisions about their own food production. They point not only to the widespread use of genetically modified foods in developed countries but also to the possibility of significantly reducing famine, malnutrition, and pesticide use.

The controversy over GM food raises the issue of environmental equity, which addresses the difference in environment quality for the rich and poor. For the most part, wealthier nations experience a cleaner environment than impoverished ones. Arguments about who can or should produce and consume GM crops often places poor countries on unequal footing with more developed countries, who can afford to be more flexible in their approaches to food production.

Part II: The Environment and Economic Development

From the earliest stages of civilization, humanity has been forced to cope with limits imposed by the earth's environment. Pastures were too often stripped bare, forests degraded, and farmland eroded. Since the Industrial Revolution gained momentum in the nineteenth century, environmental issues have increasingly come to be viewed from a global perspective. For the first time in history, environmental problems have compelled us to ponder the limits to which human activity can exploit natural resources.

Underlying this new perspective are the issues of population growth, consumption patterns, and the need for economic development.

GLOBAL POPULATION GROWTH

In ancient times, it took two thousand years for the number of people on earth to double. Since 1900, though, world population has more than tripled.

What are the reasons for population growth?

Europe's population grew rapidly in the eighteenth and nineteenth centuries, while population growth in much of Asia, Africa, and Latin America accelerated during the twentieth century. Improvements in sanitation and medicine have contributed to the decline in death rates. At the same time, new agricultural techniques have enabled many countries to increase significantly their food production and feed large populations.

For much of the second half of the twentieth century, concern was centered on fear that population growth and increased consumption would exhaust our planet's resources. In the 1970s, scholars and government officials predicted severe food, energy, and raw material shortages before the end of the century. Forecasts of mass starvation were widely accepted.

In fact, many available resources have become more plentiful, not less. Since the mid-1970s, the world's recoverable oil reserves have increased by over one-third. U.S. timber harvests are greater than ever. New exploration and extraction techniques have increased supplies of energy and minerals. Manufacturers have learned to substitute plentiful materials for scarce ones and to improve efficiency.

Our planet is now home to more than six billion people, with population growing at the rate of nearly eighty million a year. Almost 95 percent of population growth is occurring in developing countries. Population figures alone, however, are only part of the story. Equally important are the types of resources used and consumption patterns.

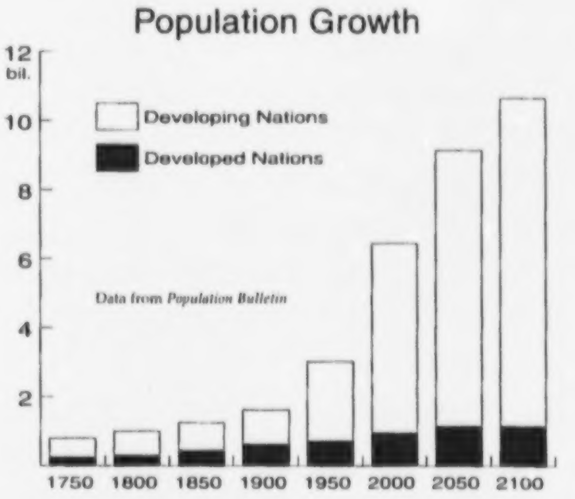
ENERGY RESOURCES

Energy is at the crux of the modern environmental dilemma. With the onset of industrialization in the late 1700s, Britain was the first country to replace wood with fossil fuels as its main source of energy. Forests were cleared and coal was increasingly used to meet Britain's ever-growing appetite for energy. In the 1800s, coal mining was expanded and oil-drilling techniques were developed.

By the turn of the twentieth century, the United States had taken the lead in forging an industrial economy powered by coal and oil. Today, these two fossil fuels, along with natural gas, supply roughly 90 percent of the world's fossil fuel energy usage.

What is the benefit of natural gas?

Substituting natural gas for oil and coal could



reduce greenhouse gas emissions. Although natural gas is a fossil fuel, it produces much less pollution than do oil and coal per unit of useful energy. Natural gas currently provides almost one quarter of the world's energy. Oil, however, is likely to power almost all of the world's more than six hundred million vehicles well into the future.

What are the alternatives to fossil fuels?

Nuclear and hydroelectric power are the most well-established alternatives to fossil fuels. Both offer greatly reduced emissions of greenhouse gases, but not without raising other problems. Nuclear power (which generates 16 percent of the world's electricity) was greeted in the 1950s with enthusiasm as a source of clean, inexpensive energy. Nuclear accidents — most notably the explosion within a nuclear power plant in Chernobyl, Ukraine, in 1986 and more recently in Tokaimura, Japan in 1999— have focused public attention on the dangers of nuclear power. Nonetheless, many countries continue to rely heavily on nuclear energy. France, for example, meets 76 percent of its electricity needs with nuclear power.

Hydroelectric power (which supplies 24 percent of the world's electricity) has also encountered mounting opposition in recent decades. As environmentalists emphasize, the dams that are necessary for hydroelectricity reduce the flow of rivers and disrupt fragile ecosystems downstream.

Newer renewable energy technologies are safe and environmentally friendly, but have been hobbled by questions of cost and feasibility. Together, they account for 9 percent of the world's energy consumption. Low fossil fuel prices have undercut economic incentives for converting to alternative energy sources. Additionally, most companies are unwilling to scrap their large power plants, in which they have invested large amounts of capital, in order to build new ones. Moreover, the political clout of America's oil, gas, and coal companies has placed fossil fuels at the forefront of U.S. policymaking, while holding back government funding for the development of renewable energy.

What is the potential of wind and solar power?

Since the mid-1980s, the price of wind power has dropped 80 percent, and it is closing in on the price of natural gas — the least expensive conventional power source — for local utility companies. Europe has 70 percent of the wind generating capacity of the world, but extensive new wind farms are being built in the United States and Brazil.

The field of solar energy has seen significant advances in the refinement of photovoltaic cells, but few American consumers have adopted the new technology. Photovoltaic cells convert sunlight to electricity. Tens of thousands of solar panels containing the cells are in use in remote areas of Africa, Asia, and Latin America that are not connected to electricity grids. U.S. companies manufacture just over a quarter of the world's solar equipment. With nearly two billion people lacking electricity worldwide, they expect their market to boom.

What additional power sources are being developed?

Geothermal and hydrogen energy are not widely used today but scientists and policy-makers expect these two energy sources to be more accessible in the near future. Geothermal power plants use the

Trends in Global Energy Use
1990-2000

Energy Source	Growth (percent)
Wind Power	838
Solar Photovoltaics	519
Geothermal Power	36.7
Hydroelectric Power	15 (1990-98)
Oil	13.5
Natural Gas	21.5
Nuclear Power	6.5
Coal	-3.7

Data from *WorldWatch Institute 2002*

hot solid or molten rock of the earth's core to heat water, producing steam which drives turbines. The consistent ground temperature just below the earth's surface can also be used for heating and cooling homes. This form of energy produces nearly no waste and is accessible all over the world.

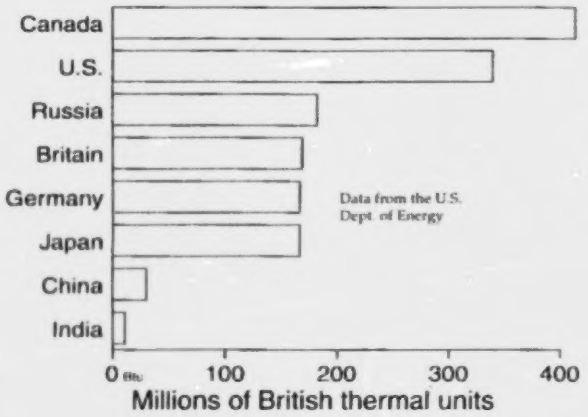
Hydrogen fuel, which is already used to power the Space Shuttle rockets, is gaining popularity because of its abundance and efficiency. Hydrogen is the most common element in the universe, and can be easily split from water in a process called electrolysis using renewable energy sources. The resulting hydrogen atoms burn cleanly and efficiently. When hydrogen and oxygen are fused into water— the opposite of electrolysis and a different reaction from the one which the Space Shuttle uses — energy is produced and can be stored in fuel cells. The byproducts of this reaction are water and heat, making hydrogen a completely clean energy source. Hydrogen fuel cell technology is currently being developed by most major automobile companies.

More experimental is fusion, which produces energy by forcing the nuclei of atoms — usually forms of hydrogen — together. Fusion promises an endless supply of power free of most of the problems of radioactive waste associated with today's nuclear power plants. An international project to build a test reactor, however, is not scheduled for completion until the middle of the twenty-first century.

RESOURCE CONSUMPTION

Although there is little population growth in the developed world, the roughly one billion people who live there consume well over half of the world's resources. For example, the consumption rate of the average American is twenty times higher (some estimates are much greater) than that of the average South Asian or African.

Per Capita Energy Consumption (1999)



Data from the U.S. Dept. of Energy

For the world's developed countries, such as the United States, Japan, and the nations of Western Europe, industrialization has raised living standards to levels previously unknown in human history. Billions of people in developing countries hope one day to have the access to the material wealth that Americans currently enjoy. Scientists warn, however, that if the developing world follows the pattern of industrialization pursued by wealthy nations over the past two centuries, the environment may be unable to support the increased level of pollution and consumption.

What are the competing theories about economic development and ecological health?

An increase in economic growth in the absence of environmental regulation could be disastrous for the world's ecology, according to many scientists. Some policymakers and economists suggest, however, that market forces and increased economic well-being will cause developing nations to "grow green;" that is, to industrialize using renewable energy sources and technology that were not available when developed nations first industrialized.

LOCAL PERSPECTIVES

The developed world: what environmental challenges do wealthy nations face?

The developed world produces over half of the world's wealth, consumes most of the world's resources, and generates the bulk of the pollutants that contribute to climate change, ozone depletion, and acid rain. The United States alone accounts for 24 percent of the world's carbon dioxide emissions.

Americans, like people throughout the developed world, are particularly dependent on oil. Although the United States is the second leading producer of oil in the world, imports amounted to a little more than 54 percent of U.S. oil consumption in 2001.

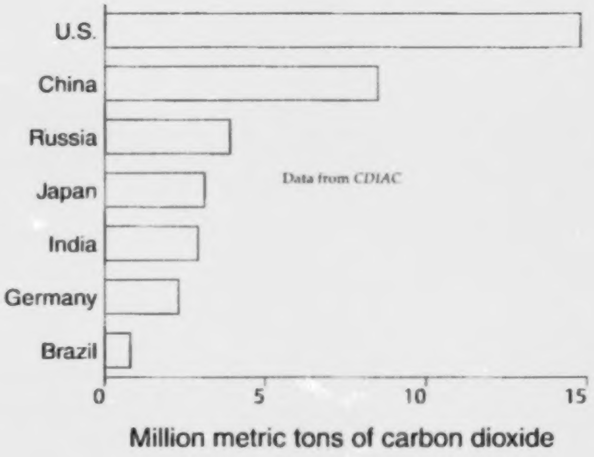
As the area that industrialized first, the developed world has experienced many of the planet's worst environmental problems. Coal use in Britain, for example, left many of the country's cities black with soot and led to severe health problems. As late as 1952, smog was responsible for the deaths of more than four thousand people in London. In recent decades, however, successful efforts have been made to reduce air and water pollution problems throughout the developed world. Developed nations have also been partially responsible for placing environmental problems on the international agenda.

The former Soviet bloc: why is this a region of special environmental concern?

The former Soviet bloc — the countries of the former Soviet Union and Central Europe — suffers from many of the worst features of industrialization. Under communism, the former Soviet bloc underwent a crash program of industrial development. Although progress was achieved in heavy industry, these countries failed to attain the affluence of the developed world. Since the collapse of the Soviet Union in 1991, economic and political problems have overshadowed environmental concerns for Russia and its neighbors.

Much of the former Soviet bloc today relies on poor-quality, high-polluting coal and energy-inefficient technologies. In Russia, for example, government subsidies have kept energy prices artificially low and have encouraged waste. As a result, Russian factories use twice as much energy as their American counterparts for the same output. Russian energy officials estimate that millions of tons of their country's natural gas production is lost to leakage and inefficiency. Meanwhile, energy producers lack the resources to upgrade their equipment. Nuclear power facilities also pose a serious threat in much of the former Soviet bloc. The Chernobyl accident heightened fears about the sixty-six other nuclear reactors in the former Soviet bloc.

Carbon Dioxide Emissions (1998)



Data from CDIAC

Newly industrializing countries: what are the environmental issues and concerns of these nations?

Newly industrializing countries consist mostly of nations in Asia and Latin America that have embarked on economic programs emphasizing rapid industrial development. Success stories for this approach include South Korea and Taiwan. Other countries, such as Mexico, China, India, and Brazil, are pursuing a similar course.

Many of these countries have made progress in curbing population growth and are now anxious to catch up with the developed world. They have turned largely to fossil fuels to transform their societies. China, for example, has become the world's largest producer and consumer of coal. By 2015, China is expected to overtake the United States as the leading emitter of greenhouse gases. (Overall, the developing world's share of carbon dioxide emissions is projected to surpass that of wealthy nations by 2020.) Coal's relative low cost and abundance has made it attractive for China and other poor countries on the road to industrialization, but there is an increasingly heavy price to be paid in the form of polluted skies and acid rain. Thirteen of the fifteen cities suffering from the world's worst air pollution are located in the newly industrializing countries of Asia.

In many emerging manufacturing areas, pollution rivals the worst period of industrialization in the

Land Degradation Caused by Human Activity, 1945-1991

(figures in millions of hectares)

Region	Overgrazing	Deforestation	Poor farming practices	Other	Total	Percentage of degraded land
Asia	197	298	204	47	746	20%
South America	68	100	64	12	244	14%
Europe	50	84	64	22	220	23%
North America	38	18	91	11	158	8%
Africa	243	67	121	63	494	22%

Data from *State of the World* 1994

United States. In Cairo, Egypt, pollutants from smelters that extract lead from used cars have stunted the mental development of some of the city's children. Chinese scientists calculate that high levels of lead pose a threat to two-thirds of the children in Shanghai. Throughout the developing world, the number of private cars has shot up, but fuel-efficiency standards and air quality regulations have not kept pace.

Leaders of newly industrializing states argue that they need to keep their farms and factories moving ahead to improve the lives of their people. Wealthier countries have agreed to help them finance the installation of new technologies to reduce greenhouse gas emissions and phase out the use of CFCs.

The developing world: how do environmental concerns affect these nations?

The developing world is composed of the poorest countries, located mostly in Africa and South Asia. In these countries, environmental problems are caused less by industrialization than by growing numbers of people relying on the land for food and fuel. Refugees forced onto marginal lands by hunger or civil war inflict the most damage. Deforestation, desertification, and declining biodiversity are as widespread in the developing world as they are in the newly industrialized countries.

The crisis facing much of the developing world is well-illustrated by the example of the Sahel region of Africa. The Sahel is an arid region located on the southern fringe of the Sahara desert. Abundant rainfall in the 1950s and 1960s led to increased farming of high-priced export crops, such as peanuts. People moved from areas in the south to cultivate crops on lands of the Sahel that had not been farmed for centuries. As more land was used for export crops, less was available to grow basic staples and to graze livestock. The over-cultivation and over-grazing in this fragile area robbed the soil of nutrients and led to erosion. When a stubborn drought began in the early 1970s, the land was unable to support the people and animals. Hundreds of thousands of people in Ethiopia, Sudan, and elsewhere in the Sahel starved as a result. The famine that struck Somalia in 1992, prompting U.S. troops to intervene to protect relief efforts, was brought on in part by the Sahel's desertification.

Because of their often desperate conditions, many developing countries are more open to far-reaching global programs. Bangladesh, the Maldives islands, and other low-lying countries are particularly concerned that a rise in sea levels brought on by climate change may flood their lands. At the same time, many developing nations also fear losing control of their natural resources to wealthier countries. For example, developing countries want a share of the profits from new products derived from plants and animals within their borders.

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Part III: Environmental Issues and the International Agenda

Since the earliest days of international diplomacy, states have generally come together to discuss matters of war and trade. The health of the environment, if considered at all, was thought of strictly in a local context. Recent years, however, have witnessed a conceptual leap.

Not only have scientific terms such as greenhouse gases and the ozone layer entered the vocabulary of public policy, but environmental problems are increasingly seen as global in scope. Because greenhouse gases are dispersed throughout the atmosphere, nations of the world recognize that climate change and the resulting environmental destruction need to be addressed in the international arena. Whether the issue is acid rain over the Great Lakes, the destruction of the rainforest in the Amazon River basin, or desertification in Africa's Sahel, there is a growing sense that the fate of the planet's ecology belongs on the international agenda.

What is the North-South divide?

In recent years political battles have pitted wealthy, developed nations against poor, developing countries. Although the geographic terminology is not perfect, writers often refer to these two groups of countries as "the North" and "the South." The dispute is not about the importance of the earth's ecology, but about questions of responsibility and obligation.

Developed nations point to the spiraling population growth rates and the often rapid industrialization of the developing world as the chief threat to the environment. They want poor countries to take stronger measures to curb population growth and address environmental problems. In contrast, developing nations point the finger at the developed economies, noting that they consume most of the world's resources and emit most of the pollutants. They argue that their need for economic development cannot be overlooked in efforts to clean up the global environment, and that rich countries should absorb the bulk of the costs in helping poor nations meet international environmental standards.

What are the origins of the disagreements between the North and South?

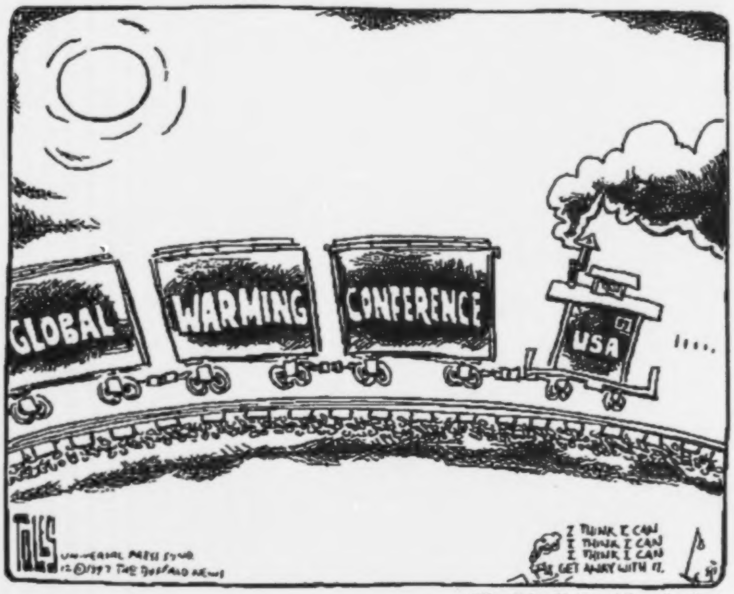
North-South issues have deep historical roots. During the nineteenth and early twentieth centuries, the leading nations of what is today the developed world competed to establish colonies abroad to gain access to raw materials and open up new markets for their manufactured goods. By the turn of the twentieth century, nearly the entire continent of Africa and much of Asia were under the control of Britain, France, and other imperial powers. U.S. colonies included the Philippines and Cuba.

Although almost all of the colonies gained independence after World War II, the impact of colonialism has continued to influence international relations. Economic links between the former colonies and the former imperial powers remain important. In addition, leaders of the developing world often blame colonialism for many of the problems that currently afflict their countries.

FROM RIO TO KYOTO

Several international conferences in recent years have raised the profile of global environmental problems and attempted to bridge the North-South divide. The 1992 conference, which took place in Rio de Janeiro, Brazil, was the largest gathering of national leaders in history and came to be known as the Earth Summit. The UN Framework Convention on Climate Change, which 150 governments signed at the Rio Conference, set in motion a series of ongoing conferences between governments on climate change that led to the 1997 conference, held in Kyoto, Japan. Most recently, policy makers, evironmentalists, and corporations met at the Conference for Sustainable Development in Johannesburg, South Africa, in September 2002.

In many respects, the North-South dispute set the tone for the agreements that emerged from the Earth Summit and the Kyoto conference. In the eight hundred pages of guidelines produced by the Earth



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Summit, many of the thorniest issues were avoided. Population growth was hardly mentioned, due to pressure from developing countries. (Population growth was addressed at the 1994 Cairo Conference on Population and Development, where there was a mandate for education as the best means of curbing population growth.) At the same time, developed nations largely succeeded in protecting corporations that operate in many countries from new regulations.

How was climate change addressed at the Earth Summit in Rio?

Signed at the Earth Summit, the UN Framework Convention on Climate Change (UNFCC) established consensus among nations to reduce or prevent greenhouse gas emissions. It also provided a framework that allowed nations to continue meeting in order to hammer out the details of reaching the general goals established in Rio. Western European nations were the most enthusiastic supporters of the treaty.

The United States has demonstrated less enthusiasm. Since signing the Convention on Climate Change, the United States has moved more slowly than Western Europe in establishing specific targets for reducing greenhouse gases. By the end of the century, U.S. greenhouse gas emissions were as much as 13 percent higher than they were in 1990.

The Earth Summit's climate change convention exempted developing nations altogether. Led by China and India, poor countries insisted that the developed world must cut greenhouse gas emissions first before developing nations would accept restrictions.

What was the purpose of the Kyoto Protocol?

The Kyoto conference was intended to put teeth in international efforts to contain climate change. Unlike the UNFCCC, the Kyoto Protocol established specific binding limits for the emissions of six greenhouse gases. As in Rio de Janeiro, however, familiar political divisions marked the Kyoto conference. The developing countries joined Western Europe in pressing for steep emission reductions in the developed world. However, they rejected constraints on their own economic growth.

What is in the Kyoto Protocol?

The treaty adopted at Kyoto affects thirty-eight countries in the developed world and the former Soviet bloc. Western Europe is required to achieve an 8 percent cutback in greenhouse gas emissions below 1990 levels during the first commitment period, between 2008 and 2012. For the United States, the target is 7 percent. For Japan, it is 6 percent. Overall, the treaty aims to reduce the greenhouse gas emissions of the thirty-eight countries affected 5.2 percent below 1990 levels between 2008 and 2012. The Kyoto Protocol calls on developing countries to voluntarily set targets for controlling emissions.

The treaty also includes a proposal put forward by the United States that would create a market for the trading of emission rights. For example, if the United States did not meet its 7 percent reduction target domestically, it could strike a deal with a country that surpasses its target. In effect, countries could trade the right to pollute. American negotiators at the conference argued that the plan would lead to more cost-effective cutbacks in greenhouse gas emissions as it has under the Clean Air Act amendments of 1990

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here in the United States.

Another part of the treaty allows the use of carbon sinks to reduce the presence of CO_2 in the air. This encourages the planting of trees, improving forest management, and conserving soils, all of which absorb carbon dioxide as a means of meeting emissions targets rather than reducing carbon dioxide emissions from transportation and industry.

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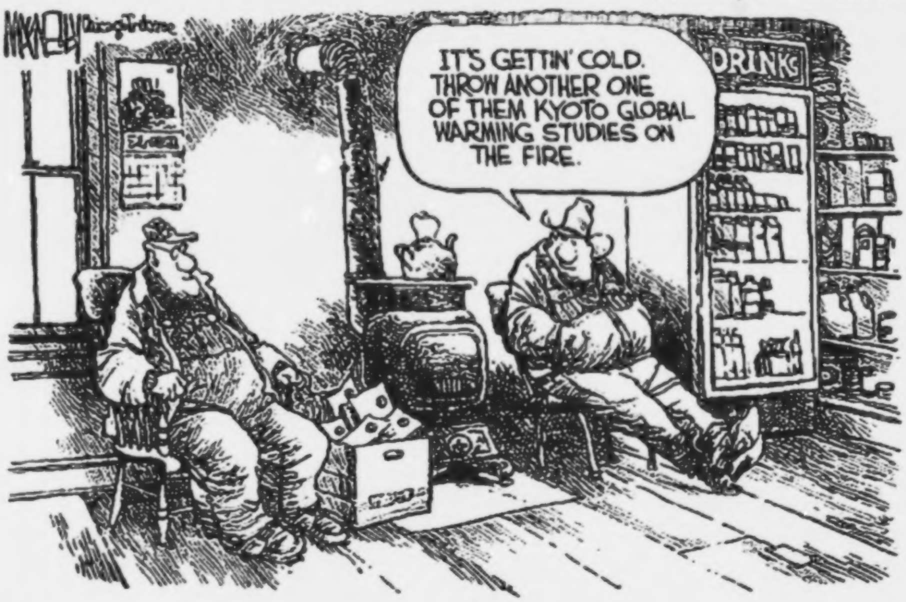
MacNELLY Chicago Tribune
IT'S GETTIN' COLD. THROW ANOTHER ONE OF THEM KYOTO GLOBAL WARMING STUDIES ON THE FIRE.
DRINK

Although nearly one hundred countries have ratified the Kyoto protocol, President Bush has said he will not sign it, citing the lack of sound science to support its goals, the threat its policies pose to world economies, and its failure to include developing nations more completely. Many Western European nations, while enthusiastic about setting targets, have not made progress towards reducing emissions since the treaty was signed. Some U.S. policy-makers have labeled such action hypocritical.

What are the obstacles to success of the Kyoto Treaty?

Forging international cooperation to enact and enforce the UNFCC and the Kyoto Protocol has proven to be very difficult. Although participants generally share a dedication to preserving the world's resources, many disagree on how to achieve that goal and who should be responsible for what. Developed nations cite the growing pollution problems of the developing world, while developing nations complain that their attempts to alleviate poverty are hampered by unreasonable rules. Since the Kyoto treaty, many analysts have said that its timetables have proven too unrealistic.

Developing nations also argue that the developed world frequently uses environmental regulations as a barrier to trade. Trucking standards, for example, have emerged as a point of contention between the United States and Mexico in recent years.

Under the North American Free Trade Agreement (NAFTA), restrictions preventing Mexican trucking companies from operating in the United States were due to be gradually lifted. Instead, American labor unions and environmental groups lobbied to block Mexican trucks from ranging farther than twenty miles beyond the U.S.-Mexican border. Much of their case was based on the argument that Mexican trucks, particularly the older models used most frequently, emit higher levels of pollutants than allowed under U.S. law. Officials from American border cities complained that increased Mexican truck traffic worsened local air pollution.

Mexican trade negotiators contended that Mexican truckers were being unfairly denied access to the U.S. market, and an international trade panel found the U.S. in violation of NAFTA. Mexican truckers maintained that environmental and safety issues were raised to protect American trucking companies from competing against the lower rates offered by their Mexican counterparts. They argued that the lengthy loading and unloading process at the border created more pollution than would allowing trucks to make deliveries in the U.S. In November, 2002, President Bush eased the restrictions after the Transportation

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Department assured that new safety measures were in place.

Another tactic cited is the role private companies play in pollution. Even as officials from developed countries urge their counterparts in poor nations to curb pollution, leading corporations often add to the environmental problems of the developing world. Many chemical manufacturers based in the United States, Western Europe, and Japan have moved factories to developing countries to take advantage of weaker pollution restrictions, inexpensive labor, and access to new markets. Likewise, logging companies have found large old-growth forests in the tropical forests of South Asia and West Africa and encounter less opposition to their operations than in the developed world.

Critics of the Kyoto Protocol note that there is no international body designed to effectively enforce the rules agreed to, so few consequences exist for nations who do not meet their targets. Some economists also suggest that negotiations should focus on specific actions nations will take, rather than targets, which are hard to agree upon and difficult to measure. They suggest imposing taxes on carbon use or offering technological and financial assistance to poor countries in order to develop renewable energy industries.

What positive outcomes have followed international cooperation?

International consensus on narrowly focused environmental goals has been fruitful. Agreements on ending the production of ozone-depleting chemicals and curbing ocean pollution are often cited as successes. The challenge, according to international observers, is to strike a balance between economic interests and environmental concerns.

In 2002, for example, environmental groups and three southern African nations butted heads over the international ban on the sale of ivory. This ban was put in place to protect elephants, which are protected under the Convention on International Trade in Endangered Species. Officials from Botswana, Namibia, and South Africa argued that they should be allowed to sell their stockpiles of ivory, much of which came from elephants who died of natural causes. They emphasized that their governments had taken effective measures to safeguard their elephant herds, and that a similar sale in 1997 increased funding for wildlife programs. The U.S. helped to negotiate a compromise that eased conservationists' fears about potential increases in poaching. Although this sale would go forward, no regular sales would be implemented in the future. Environmental groups were concerned that not enough data had been collected to indicate the elephant populations were increasing.

Although the Convention lacks the means to enforce its decisions, poor nations generally comply for fear of losing foreign aid or tourism business from the developed world.

THE JOHANNESBURG SUMMIT

At the center of the difficulty is the need to encourage economic development while providing for ecological health. The Johannesburg Summit convened forty thousand leaders in 2002 to address the complex issues surrounding sustainable development. Called the World Summit on Sustainable Development, it clearly affirmed that economic development and environmental sustainability have to be addressed together. The Summit focused on reducing poverty, increasing access to clean water and agricultural technology, and developing renewable energy technology.

Specifically, the UN agreed to halve by the year 2015 the number of people in the world who lack access to clean water. Countries also said they would halve the number of people living in abject poverty by 2015. Another outcome of the Summit was the creation of new partnerships among corporations, civilian groups, and governments which will fund development projects in various countries.

One such collaboration is between Royal Dutch/Shell Oil, six poor countries, and several banks. Shell is developing and marketing solar panels for rural areas which will replace the poor lighting systems people use in their homes. The solar-powered lighting is cleaner, brighter, and more convenient. Local banks and the World Bank provide subsidies to consumers in order to make it possible for them to purchase the new technology. In Sri Lanka the partnership has already sold en thousand new units and created one hundred jobs.

DETERMINING U.S. POLICY

No country has as much impact on the global environment as the United States. With less than 5 percent of the world's population, the United States consumes 25 percent of the world's energy and produces over 30 percent of the world's output of goods and services. In the area of international relations, the United States has occupied center stage since the 1940s and has played a prominent role in environmental affairs.

How has the United States addressed global environmental problems?

The United States can take credit for supplying much of the early initiative to address global environmental problems. The American public's concern over air and water pollution first surfaced as an important political issue in the 1960s. The passage of the National Environmental Policy Act and the creation of the Environmental Protection Agency in 1970 served as an early model for other developed countries. Public sentiment also prompted the United States in 1972 to take the lead in organizing the first major international conference, held in Stockholm, Sweden, on global environmental problems.

The U.S. response to the Rio, Kyoto, and Johannesburg conferences has been to offer partial support for the goals of each but to consistently call for increased participation from developing nations in holding down greenhouse gas emissions. The U.S. government has also been reluctant to sign international agreements it will not be able to keep.

Current United States policy reflects the idea that economies need to grow in order for environmental issues to be solved. President Bush's 2003 budget calls for fully funding the Global Environment Facility, which is charged with helping developing nations meet the goals of the 1992 Earth Summit through financial assistance. The President also seeks to

Gas Guzzling

In addition to hydrogen fuel cell technology, research in hybrid cars is increasing. Today consumers can buy cars which run on both gasoline and electricity. The gasoline motor starts the car, and then a combination of gas and electricity keeps it running forward. When the driver slows down, the electric motor harnesses the forward momentum and stores it in the battery. As the battery is depleted (when going up a hill, say) the gasoline motor kicks in.

U.S. automobile executives, however, worry that American consumers will be slow to adopt the new technologies. Although this generation of high-mileage, low-pollution cars is cheaper than earlier models, prices are higher than for cars powered by conventional engines. To win acceptance for the new technologies, the government has offered tax credits to buyers and provided more support for this industry.

Environmentalists note that taxes on gasoline in this country are a fraction of those in Western Europe and Japan. While Germans, for example, paid about $2.45 in taxes for a gallon of gasoline in 2000 and the British paid more than $3 a gallon, U.S. consumers pay, on average, less than forty cents per gallon in state and federal taxes. Opponents of so-called carbon taxes, however, argue that the economic impact would fall heaviest on poor and middle-income automobile owners.

Under President Bush, initiatives include a partnership called FreedomCAR (Cooperative Automotive Research) between the government and American automakers to design cars powered by hydrogen fuel cells. Another program seeks to mandate the installation of tire pressure monitoring systems that will help drivers keep vehicle tires inflated so they run efficiently.

Although American automakers have generally resisted government efforts to raise fuel-efficiency standards and reduce pollution, recent consumer pressure and Japanese automakers' success have prodded them to explore the new technologies.

implement policy which will enable poor countries to pay back their debts to the United States by creating wildlife refuges in their own countries and implementing conservation measures. A number of research partnerships have also been discussed between the U.S. government and corporations and between the government and other countries. Such specific projects are typical of the administration's approach to the environment. It sees particular actions as more useful and productive than targets.

President Bush has also called for a shift in focus from measuring greenhouse gas emissions alone to measuring greenhouse gas intensity. Intensity measures the ratio of emissions to economic output. The Bush administration has suggested a voluntary 18 percent cut in intensity over ten years. Such a cut is significantly lower than the one the Kyoto Protocol requires for the United States, but is similar to the average cuts required of all the Protocol's participating nations.

How has the United States addressed domestic environmental problems?

The advances in combating environmental degradation in the United States have been substantial. Over the past three decades, anti-pollution measures have resulted in marked improvements in air and water quality in the United States. The election of Ronald Reagan as president in 1980 brought a more conservative outlook on environmental issues to the White House. President Reagan and the first President Bush sought to reduce governmental regulation of the economy and, in turn, opposed environmental measures that hampered economic growth. Other industrialized countries developed very stringent policies during that time. President Bill Clinton elevated the profile of environmental issues but backed away from proposals that might threaten America's economic health.

Much of the spending on the environment in the United States is borne by businesses in response to government regulations. The 1990 Clean Air Act, for example, requires industry to reduce emissions of sulfur oxides, nitrogen oxides, and other pollutants. In 1997, President Clinton tightened air pollution standards despite protests from industry executives and big city mayors.

President Bush hopes to use the power of markets to propel technological innovation and persuade companies to reduce emissions. He favors voluntary measures rather than compulsory ones and advocates tax incentives for consumers and businesses who engage in activities which reduce emissions.

What do critics claim the United States should do to tackle future environmental problems?

Environmentalist critics of U.S. policy warn that the most difficult ecological choices lie ahead for Americans. They insist that the United States should take stronger action to limit the destruction of natural habitats and control greenhouse gas emissions. Some point to the taxes imposed by several European nations on the carbon content in fossil fuels as an example. They claim that such disincentives increase efficiency, reduce consumption, and encourage research. At the opposite pole are those who argue that existing environmental regulations undermine business and infringe unfairly on the rights of property owners.

DEBATING GOVERNMENT'S ROLE

Environmental policy touches on the government's role in the economy. Some believe that the government should invest in developing environmentally sound technologies to ensure that the United States is competitive with Japan and Western Europe in the emerging "green" market. Others have challenged the priorities of the Environmental Protection Agency and warned against accepting UN timetables to reduce greenhouse gas emissions.

How do opinions differ about government environmental policy?

Environmentalists want American business executives to follow the lead of Japan, where corporations are urged to prepare for a new phase of international competition by exceeding the environmental standards of foreign countries in which they operate.

Critics of such proposals are wary of a government hand in picking winners and losers among emerging technologies, arguing that free market competition is a better decision-maker. They contend that the cause of environmentalism is often used to camouflage the interests of those advocating expanded government control over the economy and a broader role for international organizations.

Both sides of the environmental debate appreciate that the distinction between domestic and international environmental issues has become increasingly blurred. Supporters of strong environmental measures hope that the United States will cooperate closely with other members of the international community to address environmental threats. They champion the 550 global environmental treaties that have been signed. In contrast, critics of such measures fear that, in the name of environmental protection, the United States will be hamstrung by internationally mandated regulations.

You will have an opportunity in the coming days to consider a range of alternatives for U.S. policy on global environmental issues. Each of the four viewpoints, or options, that you will explore in the next part of this unit is based on a distinct set of values and beliefs. You should think of the options as a tool designed to help you better understand the contrasting strategies from which Americans may choose.

At the end of this unit, you will be asked to create an option that reflects your own beliefs and opinions about where U.S. policy should be heading. You may borrow heavily from one option, or you may combine ideas from several options. Or you may take a new approach altogether. You will need to weigh the risks and trade-offs of whatever you decide. There are, of course, no perfect solutions.

OPTIONS IN BRIEF

OPTION 1 — PUT THE ECONOMY FIRST

In the fiercely competitive global market, the health of our nation's economy must assume top priority. We cannot afford to derail our economy in pursuit of misguided environmental goals. The environmentalists and bureaucrats who support layers of international environmental regulations are dangerously out of touch with the concerns of our country. They care little for the millions of American workers who would lose their jobs if these plans were put into effect. The answer to environmental problems does not lie in strengthening the role of international organizations in our lives. The last few decades have shown that Americans will act responsibly to reduce pollution in our country. Other nations should learn to do the same. In the meantime, we should keep our economy humming.

OPTION 2 — TAKE THE LEAD IN THE GREEN ECONOMY

Cleaning up the environment is an emerging junction between science and industry. The nations of Western Europe, Japan, and Australia have already recognized that new markets are opening up for environmentally friendly products. These countries are moving quickly to develop innovative "green" technologies. The United States cannot afford to lag behind. In the race to develop "green" technology, the United States should act decisively and avoid becoming entangled in the endless debates and disputes of international organizations. We should use our resources to develop and promote technology that will give us a jump-start in the growing market for environmentally sound products. This will allow us to strengthen our economy and reduce environmental degradation.

OPTION 3 — PROMOTE SUSTAINABLE DEVELOPMENT

Poverty around the globe is worsening, greenhouse gas emissions are rising, and resource consumption in developed nations is at an all-time high. Recognizing the interconnectedness of economic development and environmental integrity is imperative since resource degradation and depletion will ultimately preclude further development. We must join with the other countries of the world—both developed and developing—and work with people at the local level, under the auspices of the UN, to achieve a globally sustainable balance of development and environmental preservation. A cooperative and very deliberate effort is needed to promote growth, reduce poverty, and protect the planet.

OPTION 4 — PROTECT MOTHER EARTH

With the survival of the planet at stake, global environmental problems outweigh all other national interests and must rank as our top priority. Because environmental issues are ultimately global in scope, we must also pressure the UN to make protection of the earth's environment its top priority. Unless we make major changes in the way people live, we are all headed for catastrophe. We must pass legislation in the United States that will end the use of all fossil fuels and stop greenhouse gas emissions, and we must pressure other nations to do the same. Any initiatives designed to address economic issues must be assessed for their current and potential environmental impacts. Such assessments must place a premium on future environmental value because we have a responsibility to safeguard the world for future generations.

Option 1

PUT THE ECONOMY FIRST

In the fiercely competitive global market, the health of our nation's economy must assume top priority. For two decades, American companies have worked hard to regain their leadership position internationally. Despite recent fluctuations, our economy remains strong. We cannot afford to derail our economy in pursuit of misguided environmental goals. The environmentalists and bureaucrats who support layers of international environmental regulations are dangerously out of touch with the concerns of our country. They care little for the millions of American workers who would lose their jobs if their plans were put into effect. Rather, they insist that factories be closed and our living standards be cut in the name of a distant and uncertain threat, even as scientists continue to debate the meaning of confusing research data.

The answer to environmental problems does not lie in strengthening the role of international organizations in our lives. We would be foolish to hamstring our economy with environmental restrictions while allowing the emerging powers of the developing world a free ride. The last few decades have shown that Americans will act responsibly to reduce pollution in our country. No one wants to destroy the ecology of his or her own backyard. Other nations — especially those with skyrocketing populations and high-polluting industries — should also learn to act responsibly. In the meantime, we should keep our economy humming and keep obstructive government policies out.

What policies should we pursue?

- We should withdraw from international environmental agreements that limit U.S. authority over our country's economic and environmental policies.

- We should promote economic growth by relaxing burdensome environmental regulations — such as fuel efficiency and pollution standards that hinder the auto industry.

- We should cut off foreign aid that supports the UN's growing bureaucratic web of environmental programs.

- We should scale back state and federal regulations that increase our country's dependence on imported energy by hampering the development of our own oil, coal, and natural gas resources.

- We should ensure that measures to protect our environment do not interfere with economic growth.

How would Option 1 affect us?

The U.S. government would do little to interfere with the progress of industry. In areas where environmental restrictions have stifled the economy, regulations would be revised. Oil, coal, and natural gas would continue to serve as our most important sources of energy over the next decade. The government would not discourage Americans from buying big cars or drilling in wilderness areas. The environment would be negatively affected as greenhouse gases increase and forests are destroyed. Eventually, however, market forces and our continued economic health might lead to improved technology and lower prices for renewable energies. In the short term, our lives would change little under Option 1. Pollution would increase, but some industries would benefit from relaxed pollution standards and provide more jobs.

PROS & CONS

SUPPORTING ARGUMENTS

1. Relaxing environmental regulations will give U.S. industries an opportunity to cut costs and create new jobs.
2. By proceeding cautiously in response to the current sensationalism regarding environmental problems, the United States will avoid rash policy decisions and be in a better position to weigh ongoing scientific research.
3. Staying out of restrictive international environmental agreements will allow the United States to maintain control over its environment and economy.
4. Withdrawing U.S. support for international environmental agreements will prevent the efforts of UN bureaucrats from expanding the regulatory power and authority of international organizations.

OPPOSING ARGUMENTS

1. Withdrawing from international environmental agreements will undermine decades of progress to combat pollution worldwide and doom future attempts to address global environmental problems.
2. Unless we give environmental problems a high priority, U.S. science and industry will fall behind in an expanding field.
3. Neglecting environmental problems now will result in still greater harm to the health of both future generations and the planet as a whole. We would begin to see increased respiratory problems in people and increases in chemical toxins in both people and animals.
4. By refusing to work with other countries on global environmental issues, the United States will find itself isolated from much of the international community and will lose its reputation as a strong leader.

Option
2

TAKE THE LEAD IN THE GREEN ECONOMY

Cleaning up the environment is an emerging junction between science and industry. The nations of Western Europe, Japan, and Australia have already recognized that new markets are opening up for environmentally friendly products. These countries are moving quickly to develop innovative "green" technologies. The United States cannot afford to lag behind; we must remain on the cutting edge, where science and industry converge. As such, we must work diligently to develop alternatives to fossil fuels and gain a head start on pioneering the technologies of the twenty-first century. It would be foolish to pass up the economic growth and power to be gleaned from developing such technology and products.

In the race to develop "green" technology and products, the United States should act decisively and avoid becoming entangled in the endless debates and disputes of international organizations. We have neither the time nor the desire to be constrained by their regulations and roadblocks. Why continue to invest time, money, and effort in useless international initiatives that hurt our economy by hampering growth and development while doing little to improve the environment? Instead, we should use our resources to develop and promote technology that will give us a jump-start in the growing market for environmentally sound products, including energy. This clean technology will allow us to strengthen our economy and reduce environmental degradation. Investing this way will ensure a better world for future generations of Americans by increasing economic gains and improving world-wide environmental health.

What policies should we pursue?

- We should invest in research and development of environmental technologies — especially in the area of renewable energy — that will be in demand internationally.

- We should provide tax credits and other financial incentives to promote energy-efficient technologies, conservation, and the use of alternatives to fossil fuels.

- We should create financial disincentives for companies who don't make the technological leap to environmentally friendly practices.

- We should create a corps of environmental specialists to research and develop new technologies.

- We should make sure that new international environmental treaties and conventions do not harm U.S. interests — both economic and environmental.

How would Option 2 affect us?

The U.S. government would actively encourage the development of new technologies designed to cope with environmental problems. Industries producing environmentally friendly technologies would receive special tax breaks. Solar, wind, and other non-polluting energy sources would benefit from government-sponsored research programs. In the short term, Americans would have to pay higher taxes to fund Option 2. In addition, tax disincentives would hurt a few heavily polluting industries. Some companies would relocate to developing countries to avoid limits on greenhouse gas emissions, leaving American workers unemployed. At the same time, though, the development of environmentally sound technologies would create new businesses and new jobs for the long term.

PROS

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CONS

SUPPORTING ARGUMENTS

1. Developing environmentally sound technologies will put the United States in the lead in a crucial field and generate new jobs.

2. Investing now to break our dependence on fossil fuels and promote energy efficiency will give U.S. industry a key competitive edge for the future.

3. Demonstrating dedication to the environment will strengthen America's reputation as a benevolent superpower.

4. Introducing environmentally sound technologies developed by U.S. industry will eventually help clean up pollution worldwide.

OPPOSING ARGUMENTS

1. By acting alone in pursuing global environmental policies, the United States will offend and possibly undermine our key allies and trading partners in the developed world that have already taken collaborative steps to address global environmental problems.

2. Developing nations will be unable to grow in environmentally sound ways unless we cooperate to give them access to green technology. It is short-sighted to see the development of this technology as primarily an economic issue.

3. Considering the fierce competition of the global economy, our country cannot afford to suddenly shift policies and invest in unproven technologies at the expense of our important oil, gas, and coal industries.

4. Although investment in green technologies may contribute to a cleaner environment, too many of the problems of the global environment will not be addressed if our policies are driven solely by economic gain.

Option
3

PROMOTE SUSTAINABLE DEVELOPMENT

Poverty around the globe is worsening, greenhouse gas emissions are rising, and resource consumption in developed nations is at an all-time high. Recognizing the interconnectedness of economic development and environmental integrity is imperative since resource degradation and depletion may ultimately preclude further development. It is undeniable that development is needed to promote economic growth, increase education and stability, and reduce poverty. Half of the world's population subsists on less than two dollars a day, living in desperate conditions with little access to clean water, medical care, or educational opportunities. Balancing necessary development with the need to reduce environmental stress requires global cooperation. Only by joining the efforts of private companies, governments, and other organizations can we hope to successfully accomplish this balancing act.

With a lack of funds and technology, poor countries see little choice but to develop in environmentally unsound ways. It would be both unfair and unwise for the developed world to turn a blind eye on the developing world. Unfair because the United States and most of the North had the opportunity to develop before strict environmental regulations came to be. Unwise because we cannot isolate ourselves from the environmental damage that would result from such a decision. We must join with the other countries of the world — both developed and developing — and work with people at the local level, under the auspices of the UN, to achieve a globally sustainable balance of development and environmental preservation. By increasing foreign aid, ensuring that global trade operates freely and fairly, and imposing strict regulations for pollution, we will help to implement environmentally responsible policies in poor countries. A cooperative and very deliberate effort is needed to promote growth, reduce poverty, and protect the planet.

What policies should we pursue?

- We must join with the richer and more developed countries of the world to increase foreign aid targeted for environmentally sound projects in developing countries.

- We should promote public-private partnerships which fund projects and provide expertise to developing countries seeking to address environmental problems while allowing for economic growth.

- We should work within the UN structure to set the international agenda on global environmental problems while working with people at the local level to ensure that their needs are met.

- We should reduce consumption here at home and impose regulations to decrease greenhouse gas emissions and other pollutants.

- We should work to free up the world trade system, including reducing the U.S. government's manufacturing subsidies, to make sure that it offers fair competition so that all nations can participate equitably.

- We should support international science and policy projects focusing on achieving environmentally sustainable development.

How would Option 3 affect us?

The U.S. government would strengthen regulations to clean up the environment in accord with UN mandates. In cooperation with the other countries of the world, we would invest public funds into the development of industries that are capable of prospering in harmony with the environment. Companies in the U.S. that are producing environmentally friendly products would prosper and expand. Over time, industries that are unable to adapt would find themselves phased out. Our dependence on gasoline-powered cars would eventually give way to reliance on cleaner forms of transportation. In the short term, Americans would have to pay significantly higher taxes to fund Option 3. In the long term, however, as the overall health of the world improves, our way of life would improve. Over time, Americans would find their foreign aid budget (sharply increased on the short term) reduced as responsible growth takes root in developing nations. Reductions in pollution would benefit us all.

PROS

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SUPPORTING ARGUMENTS

1. Helping rapidly industrializing countries to pursue environmentally friendly development will improve the health of people in poor countries, thereby reducing the need for aid later.

2. Giving aid to poor countries and increasing environmental regulations at home will help the U.S. to regain its prominence as a leader in environmental affairs and global development.

3. Promoting consensus among countries on global environmental problems will pave the way toward greater cooperation on other international problems.

4. Concentrating the economic muscle of the U.S. behind the cause of protecting the global environment will establish a new standard for fair, responsible trade.

CONS

OPPOSING ARGUMENTS

1. The bureaucracy and regulations required to coordinate international environmental efforts will be one more strand of red tape holding down the growth of U.S. businesses.

2. The United States cannot afford to increase foreign aid for environmental programs elsewhere at the expense of our needs here at home.

3. Just as the Europeans and Japanese take advantage of U.S. policies promoting free trade, they could use environmental cooperation to gain an unfair competitive edge.

4. The immediacy of global environmental problems requires undivided attention to the long-term health of the planet before we can begin to address economic needs.

Option
4

PROTECT MOTHER EARTH

With the survival of the planet at stake, global environmental problems outweigh all other national interests and must rank as the top priority on our national agenda. Other issues—like the budget deficit, the war on terrorism, and world poverty—are serious, but the looming environmental crisis threatens the very existence of humanity. We must focus on the environment above all else. Because environmental issues are ultimately global in scope, we must pressure the UN to make protection of the earth's environment its top priority. We must all—developed and developing nations alike—reduce the threats of global warming, pollution, overpopulation, and deforestation. Unless we make rapid, major changes in the way people live, we are all headed for catastrophe. With each day's delay, the costs of reversing damage increase drastically.

If we are going to pass along a healthy planet to our children, we must all accept responsibility for reducing our consumption of resources. We must pass legislation in the United States that will end the use of all fossil fuels and stop greenhouse gas emissions, and we must pressure other nations to do the same. Likewise, we must significantly increase our dedication to preserving biological diversity by developing more conservation parks and enlisting other nations in this effort. Any development initiatives designed to address economic issues must be assessed for their current and potential environmental impacts and will only be adopted if they cause no harm to the environment. Such assessments must place a premium on future environmental value, recognizing both the economic and environmental costs. We should turn away from new technologies — such as genetically modified foods or nuclear power — that have unknown and/or potentially dangerous consequences. We are all citizens of the same fragile planet, and as such we all have a responsibility to safeguard the world for future generations.

What policies should we pursue?

- We should reduce the amount of resources we consume and shift our national priorities so that the environment comes first.
- We should phase out the use of fossil fuels and commit ourselves to rapidly reducing the emission of carbon dioxide and other greenhouse gases.
- Industries should receive government assistance to help them meet strict new environmental standards.
- We should join with the international community to grant authority to the UN to establish strong international environmental laws and take part in enforcing global environmental standards.
- We should halt the use of genetically modified organisms to prevent potential damage to biological diversity and human health.
- We should increase aid to developing countries and provide technology so that they can address environmental problems at the local level and can phase out high-polluting industrial processes.
- We should promote programs that help to control the world's population, such as increasing education for girls and women.

How would Option 4 affect us?

The U.S. government would tighten regulations to clean up the environment and introduce measures to restructure our economy based on environmentally sound principles. We would move quickly toward cutting carbon dioxide emissions and developing non-polluting energy sources. Government incentives would be offered to industries that are environmentally clean and tough restrictions would be imposed on those that pollute. In the short term, significantly stricter environmental standards would harm many industries and lead to higher — though more realistic — prices for many goods. Many workers would face unemployment, at least temporarily, as we shift our focus to the environment. As individuals, we would also have to make changes in our way of life, such as paying higher taxes for gasoline. In the long term, though, Americans — and everyone — would benefit from improved environmental quality and could expect better personal health as pollution decreases. Most importantly, we would feel that we are leaving the planet cleaner for generations to come.

PROS

SUPPORTING ARGUMENTS

1. Reducing consumption of resources will result in a cleaner environment worldwide and an improvement in the health of the planet.
2. Giving developing countries economic assistance to help them solve global environmental problems will help heal North-South divisions and improve America's image throughout the world.
3. Expanding assistance to the developing world will slow the unchecked population explosion and reduce future threats to our planet's resources.
4. Protecting biodiverse areas ensures humanity will be able to access as-yet unknown resources for medicine and other benefits for humankind.

&

CONS

OPPOSING ARGUMENTS

1. An avalanche of stringent environmental regulations and big increases in government spending to fund new international environmental programs will drag down our economy for years to come.
2. Focusing exclusively on environmental issues will neglect the important economic development needs of poor countries and will risk alienating them from the discussion.
3. U.S. industry, striving to sharpen its competitive edge, will be reluctant to develop new environmentally friendly technologies that would be shared with other countries.
4. By strengthening the authority of the UN on environmental policy, the United States will be relinquishing power to govern our country's land, water, and air.

Optional Reading: Following the Path of the Carbon Cycle

Carbon is a basic building block of life on earth. Every plant and animal — from single-celled amoebas to gigantic redwoods to our own human form — contains carbon. Carbon dioxide (CO_2), either present in the air or dissolved in water, is the source of the carbon found in most living matter.

Carbon dioxide is constantly on the move in the biosphere, involving the interaction of the atmosphere, oceans, and land. Scientists call this process the "carbon cycle." Throughout most of the earth's recent history, there has been a rough balance between sources of carbon dioxide — such as decaying organic matter, animal and plant respiration — and sinks (or reservoirs) of carbon dioxide — such as living plants. Many aspects of the carbon cycle are measured in terms of decades, centuries, millennia, or even millions of years.

How has human activity affected the carbon cycle?

Human activity has disturbed the natural carbon cycle, especially since the onset of industrialization. In the modern era, oceanic and terrestrial carbon sinks have not absorbed the additional carbon dioxide discharged into the atmosphere by human activity. In 1750, the concentration of carbon dioxide in the atmosphere was 280 parts per million by volume (ppmv). Today, it is approaching 370 ppmv. Humanity has added extra carbon dioxide to the carbon cycle mainly through the combustion of fossil fuels and the spread of agriculture and grazing.

Fossil fuels represent carbon that was removed from the atmosphere in ages past by living plants and animals. When these organisms died, their remains accumulated in the earth's crust and were transformed into the deposits of oil, coal, and gas that we use today.

Fossil fuels were formed over millions of years. Since the late eighteenth century, however, humanity has been consuming fossil fuels at an accelerating rate. For example, scientists believe that nearly one-third of the world's oil reserves have already been depleted. As a result, carbon dioxide that had been stored in sedimentary layers for millions of years is suddenly being released into the atmosphere.

At the same time, the conversion of wilderness to farmland and pasture has reduced the capacity of the terrestrial biosphere to serve as a carbon sink. By clearing away forests and allowing livestock to strip away vegetation, humanity destroys plant life which stores carbon. Plowing the soil to prepare for planting also accelerates the decomposition of organic matter, leading to the release of carbon dioxide.

How do photosynthesis and respiration relate to the carbon cycle?

A study of the carbon cycle requires an understanding of photosynthesis and respiration, the biological processes which sustain life both on land and in water. In photosynthesis, green plants and certain other organisms convert water and atmospheric carbon dioxide into simple carbohydrates, or sugar. The chlorophyll present in green plants acts as the catalyst (a substance that causes or accelerates a chemical reaction without being affected itself), while sunlight provides the energy source.

Reaction of photosynthesis in green plants:

$$CO_2 + 2H_20 \xrightarrow{\text{light}} (CH_2O) + O_2 + H_2O$$

The carbohydrates produced by photosynthesis are the foundation of the food chain. The chemical energy generated by photosynthesis is put to work in the process of respiration to carry out cellular functions essential to life. Within the cells of organisms, enzymes break down the carbohydrates and other foodstuffs resulting from photosynthesis into the energy-rich compound adenosine triphosphate (ATP) or into components used for the production of the cell's macromolecules. (Some organisms break down foodstuffs through fermentation, a process that does not require oxygen.)

In the case of humans, we either eat the products of photosynthesis directly in the form of plants or indirectly in the form of animals that, in turn, have themselves consumed plants or plant-eating animals.

Photosynthesis also plays a fundamental role in the carbon cycle. In carrying out photosynthesis, plants remove carbon dioxide from the atmosphere. The carbon is then "fixed" within the tissue of living plants or utilized for respiration. In addition, oxygen is released as a by-product of photosynthesis.

Carbon dioxide is returned to the atmosphere in the process of respiration. Animals take in oxygen and discharge carbon dioxide in the course of respiration. (In contrast to animals, plants consume more carbon dioxide in photosynthesis than they release through respiration.) Carbon dioxide is also released into the atmosphere when wood and other organic matter burn or decay.

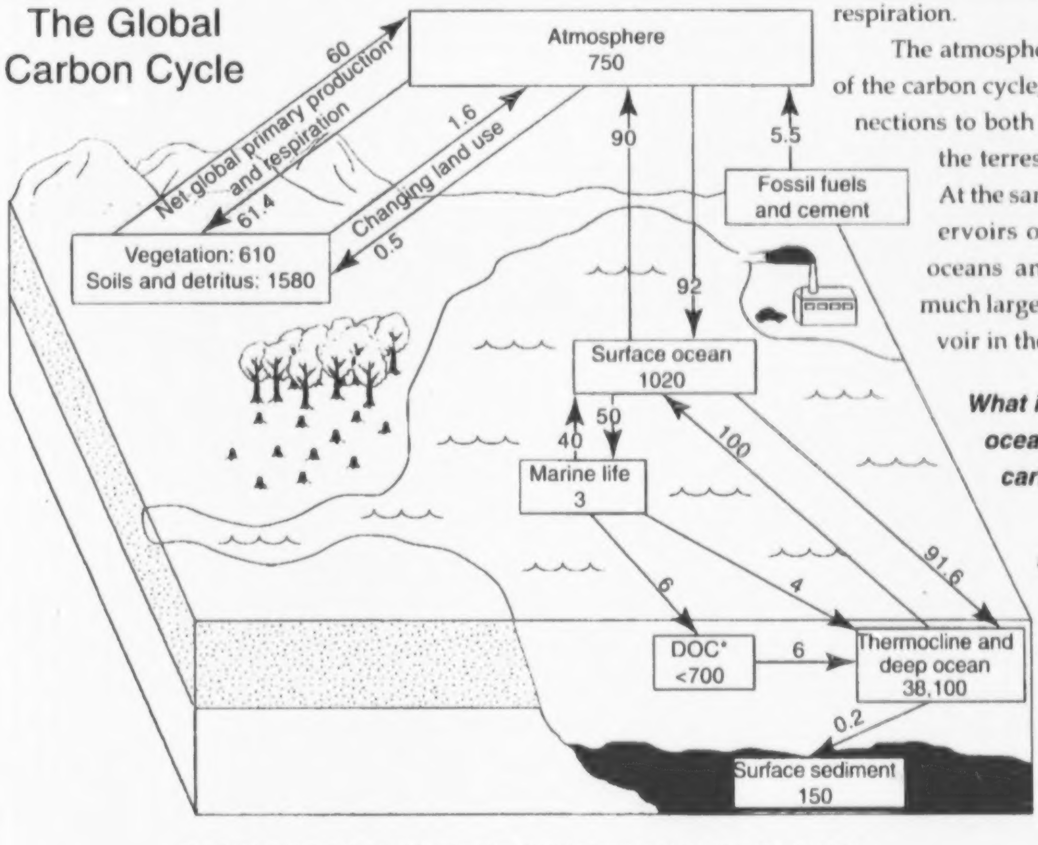
How does the carbon cycle work?

Photosynthesis and respiration ensure that carbon dioxide is forever cycling between the atmosphere, the oceans, and the terrestrial biosphere. At the same time, carbon is being deposited in the earth's crust as layers of sediment.

Scientists have identified five key processes in the carbon cycle (see the graph below):

- The exchange of carbon dioxide between the atmosphere and the ocean;
- The exchange of carbon dioxide between the surface waters of the ocean and long-term storage in the deep ocean;
- The net release of carbon dioxide from changes in land use, such as deforestation;
- The photosynthesis of land plants, thus transferring carbon dioxide into long-term storage in wood and soils;
- The release of carbon dioxide into the atmosphere through plant and soil respiration.

The atmosphere is the buffer of the carbon cycle, with vital connections to both the oceans and the terrestrial biosphere. At the same time, the reservoirs of carbon in the oceans and on land are much larger than the reservoir in the atmosphere.


The Global Carbon Cycle
Atmosphere
750
60
Net global primary production and respiration
61.4
1.6
Changing land use
0.5
90
92
5.5
Fossil fuels and cement
Vegetation: 610
Soils and detritus: 1580
Surface ocean
1020
50
40
Marine life
3
100
91.6
6
4
DOC*
<700
6
Thermocline and deep ocean
38,100
0.2
Surface sediment
150

Reprinted from *Climate Change 1994*, a report by the UN Intergovernmental Panel on Climate Change

The numbers in the boxes indicate the size of each carbon reservoir in GtCs (1 GtC = 1 billion metric tons of carbon; 1 metric ton = 1,000 kilograms, or 2,204 pounds). The numbers matched with the arrows indicate the annual magnitude of carbon exchange in GtCs for the period between 1980 and 1989. (*DOC = dissolved organic carbon.)

What is the role of oceans in the carbon cycle?

The oceans are the largest depository for excess carbon dioxide in the atmosphere. More than fifty times as much carbon is present in the oceans than in the atmosphere. Over 95 percent of oceanic carbon is in the form of inorganic dissolved carbon (bicarbonate and carbonate ions). The remainder consists of organic carbon, such as sea plants and particulate and dissolved organic carbon.

The oceans absorb carbon dioxide through a three-step process:

- Carbon dioxide from the atmosphere is consumed by phytoplankton (microscopic plants, particularly algae) in the surface layer of the ocean during photosynthesis;
- Although most of the carbon dioxide is returned to the atmosphere, water circulation gradually transports dead plants and other organic matter containing carbon from surface waters to the mid-level thermocline layer and the deep ocean.
- As the organic matter decays, carbon dioxide is released into the water, and most of it becomes absorbed in the sea by chemically combining with water molecules to form carbonic acid (H_2CO_3).

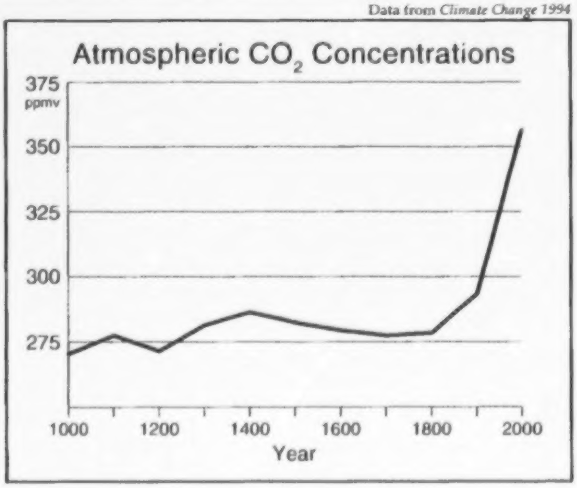
While the ocean serves as the earth's largest carbon sink, the process of oceanic carbon cycling takes place on a timescale of decades and centuries. Consequently, the ocean is not capable of absorbing a sudden increase in atmospheric carbon dioxide. For this reason, the relatively small human sources of carbon dioxide loom much larger when viewed in the time frame of the carbon cycle.

Returning the level of carbon dioxide in the atmosphere to pre-industrial levels would take hundreds of years, regardless of the actions humanity takes. Even if carbon dioxide emissions could be held steady at present rates, scientists predict that atmospheric concentrations of carbon dioxide would rise for at least two centuries. By 2100, they would reach five hundred ppmv, or nearly double the pre-industrial level.

What role does the terrestrial biosphere play in the carbon cycle?

The carbon reservoir on land consists of carbon dioxide that has been fixed within vegetation and soil, and, most significantly, deposited in layers of sediment. Up to 80 percent of the carbon above ground in the terrestrial biosphere and one-third of the carbon below ground are contained within forests. The two largest terrestrial sinks of carbon — the forests of Russia and the Amazon Basin — hold nearly half of the carbon stored in the world's forests. In the last two centuries, the process of carbon fixation in the terrestrial biosphere has increasingly been disturbed by changes in land use from human activity.

Data from *Climate Change 1994*



Humanity has also built modern society on the energy resources of the terrestrial biosphere. Since the beginning of industrialization, scientists estimate that emissions from the burning of fossil fuels have pumped 230 billion metric tons of carbon dioxide into the atmosphere. (To a much smaller degree, cement production has also released carbon dioxide.)

In the 1990s, fossil fuel emissions averaged roughly thirty-two million tons per year. Scientists have determined that the concentration of carbon dioxide in the global environment rose by 1.57 ppmv annually during the decade. The increase corresponds to an addition of thirty-six million tons to the atmosphere every year. Changes in land use from human activity also inject carbon dioxide into the atmosphere.

How can the human component in the carbon cycle be calculated?

Calculating humanity's effect on the carbon cycle is not a straight-forward exercise. Human activity is not only a source of carbon dioxide, but may also contribute to promoting carbon sinks. The following is a summary of the key factors in assessing humanity's role.

Deforestation and changes in land use: Burning organic matter and clearing away trees emit carbon dioxide to the atmosphere through the oxidation of vegetation and soil carbon. From 1850 to 1990, deforestation and changes in land use resulted in emissions of 122 GtCs. Before the 1950s, the developed world was responsible for most of these emissions. Today, most of the carbon dioxide emissions from deforestation and changing land use are attributed to developing countries. During the 1980s, this class of emissions from the developing world totaled 1.6 GtCs annually.

Forest regrowth: As forests recover from logging, the new trees absorb carbon dioxide. Recent studies suggest that more carbon dioxide is now being absorbed by the forests of the developed world than is being released. Scientists estimate that the extent of the net carbon sink from the forests of the Northern Hemisphere ranges from roughly zero to 0.74 GtC annually.

Carbon dioxide fertilization: Studies show that heightened levels of atmospheric carbon dioxide result in increased rates of photosynthesis. Potentially, carbon dioxide fertilization could promote faster plant growth and lead to increased carbon storage in the terrestrial biosphere.

Nitrogen fertilization: Much like carbon dioxide fertilization, increased emissions of nitrogen into the atmosphere could result in increased plant growth and terrestrial carbon storage. Nitrogen is released through the combustion of fossil fuels and organic matter, and the use of chemical fertilizers.

Weighing the human component in the carbon cycle is further complicated by the interaction of the factors under consideration. The relationship between nitrogen and forest regrowth offers a good example. Nitrogen emissions, which are produced mostly by developed countries, tend to have a more localized effect than carbon dioxide emissions. Consequently, the forests of the developed world have experienced greater nitrogen fertilization than forests near the equator. At the same time, emissions of nitrogen oxides and sulfur oxides are the primary agents of acid rain. Scientists have shown that acid rain has damaged the health of many forests near industrial centers of the developed world. (See the table below for a summary of humanity's carbon budget.)

How do current carbon dioxide levels compare with those from an earlier era?

While the balance of human forces remains complex, scientists are increasingly confident of their ability to measure the consequences of human activity in the carbon cycle. Their analysis indicates that the increase in atmospheric carbon dioxide concentrations to nearly 370 ppmv marks a sharp break with the recent past. During the last ice age, carbon dioxide levels were roughly 190-200 ppmv, or 70 percent of pre-industrial concentrations. Beginning about eighteen thousand years ago, the earth gradually began to warm. Over the next ten thousand years, the mean surface temperature rose by 4 degrees Celsius and atmospheric carbon dioxide concentrations climbed at least 80 ppmv. During the last thousand years, carbon dioxide levels have fluctuated up to 10 ppmv per century around an average value of 280 ppmv.

Summary of Humanity's Annual Carbon Budget
(1980-1989)

Anthropogenic (human) CO_2 sources

Emissions from fossil fuels and cement production:	5.5 GtC/yr
Net emissions from changes in land use in developing countries:	1.6 GtC/yr

Sinks of anthropogenic CO_2

Storage in the atmosphere:	3.2 GtC/yr
Ocean absorption:	2.0 GtC/yr
Absorption by forest regrowth in the Northern Hemisphere:	0.5 GtC/yr
Additional terrestrial sinks (mainly CO_2 and nitrogen fertilization):	1.4 GtC/yr

Scientists believe that earlier

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Tools of measurement

Since the late 1950s, scientists have directly measured atmospheric concentrations of carbon dioxide from observation stations in Antarctica and Hawaii. To reach back into the past, however, they must rely on indirect measurement tools. Most useful has been the analysis of ice cores extracted from the massive icecaps surrounding the North and South Poles. The ice cores contain bubbles of air that was trapped as snow turned into ice.

Through their knowledge of carbon isotopes, scientists have determined that increased levels of atmospheric carbon dioxide are attributable to industrialization. Carbon-12 (C^{12}) and carbon-13 (C^{13}) are the most common carbon isotopes. When fossil fuels and organic matter are burned, the carbon that is released has a lower ratio of carbon-13 to carbon-12 than that which is generally found in the atmosphere.

Analysis of carbon dioxide has shown that the atmospheric level of carbon-13 relative to carbon-12 has declined about 1 percent over the last century. Such a decrease is consistent with humanity's emissions of carbon dioxide from the burning of fossil fuels and organic matter.

fluctuations in carbon dioxide levels were caused by the influence of climatic changes on the oceanic and terrestrial ecosystems. They emphasize, however, that even the most dramatic swing in carbon dioxide levels, which occurred from 1200 to 1400, is small compared to the build-up of the twentieth century.

Why is understanding "climate feedback" important?

Most challenging from a scientific standpoint — and most critical for humanity's future — is calculating the impact of climate change on the carbon cycle. Scientists call this effect "climate feedback."

The implications of climate change are likely to be most immediate for the terrestrial biosphere. On the one hand, the higher temperatures and increased precipitation that are expected to result from climate change should contribute to greater photosynthesis, faster plant growth, and higher levels of carbon fixation in living vegetation. On the other hand, rapidly changing climatic conditions would leave many species of plants unable to adjust. Vast swaths of forest could be wiped out. Higher temperatures and the erratic rainfall patterns that are forecast could lead to devastating droughts. Moreover, higher temperatures speed up the rate of decomposition of organic matter, thus reducing the capacity of soil to store carbon.

Emissions of carbon dioxide and other pollutants also increase the acidity of rainfall. In turn, acid rain contributes to the erosion of sedimentary rocks, such as limestone, where most of the earth's carbon is stored. Accelerated rates of erosion would inject additional carbon into the carbon cycle.

For the oceanic ecosystem, climate change is expected to have the greatest impact on ocean circulation and chemistry. Changes in water temperature and circulation patterns would have serious consequences for algae and other marine plants, and may impede the chemical reaction between carbon dioxide and dissolved inorganic carbon. The changes would, in turn, affect the exchange of carbon dioxide between the oceans and the atmosphere.

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Supplementary Documents

Rio Declaration on Environment and Development

The United Nations Conference on Environment and Development,

Having met at Rio de Janeiro from 3 to 14 June 1992,

Reaffirming the Declaration of the United Nations Conference on the Human Environment, adopted at Stockholm on 16 June 1972, and seeking to build upon it,

With the goal of establishing a new and equitable global partnership through the creation of new levels of cooperation among States, key sectors of societies and people,

Working towards international agreements which respect the interests of all and protect the integrity of the global environmental and developmental system,

Recognizing the integral and interdependent nature of the Earth, our home,

Proclaims that:

Principle 1

Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

Principle 2

States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

Principle 3

The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations.

Principle 4

In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.

Principle 5

All States and all people shall cooperate in the essential task of eradicating poverty as an indispensable requirement for sustainable development, in order to decrease the disparities in standards of living and better meet the needs of the majority of the people of the world.

Principle 6

The special situation and needs of developing countries, particularly the least developed and those most environmentally vulnerable, shall be given special priority. International actions in the field of environment and development should also address the interests and needs of all countries.

Principle 7

States shall cooperate in a spirit of global partnership to conserve, protect, and restore the health and integrity of the Earth's ecosystem. In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.

Principle 8

To achieve sustainable development and a higher quality of life for all people, States should reduce and eliminate unsustainable patterns of production and consumption and promote appropriate demographic policies.

Principle 9

States should cooperate to strengthen endogenous capacity-building for sustainable development by improving scientific understanding through exchanges of scientific and technological knowledge, and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies.

Principle 10

Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

Principle 11

States shall enact effective environmental legislation. Environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply. Standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries, in particular developing countries.

Principle 12

States should cooperate to promote a supportive and open international economic system that would lead to economic growth and sustainable development in all countries, to better address the problems of environmental degradation. Trade policy measures for environmental purposes should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade. Unilateral actions to deal with environmental challenges outside the jurisdiction of the importing country should be avoided. Environmental measures addressing transboundary or global environmental problems should, as far as possible, be based on an international consensus.

Principle 13

States shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage. States shall also cooperate in an expeditious and more determined manner to develop further international law regarding liability and compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction.

Principle 14

States should effectively cooperate to discourage or prevent the relocation and transfer to other States of any activities and substance that cause severe environmental degradation or are found to be harmful to human health.

Principle 15

In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Principle 16

National authorities should endeavor to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.

Principle 17

Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.

Principle 18

States shall immediately notify other States of any natural disasters or other emergencies that are likely to produce sudden harmful effects on the environment of those States. Every effort shall be made by the international community to help States so afflicted.

Principle 19

States shall provide prior and timely notification and relevant information to potentially affected States on activities that may have a significant adverse transboundary environmental effect and shall consult with those States at an early stage and in good faith.

Principle 20

Women have a vital role in environmental management and development. Their full participation is therefore essential to achieve sustainable development.

Principle 21

The creativity, ideals and courage of the youth of the world should be mobilized to forge a global partnership in order to achieve sustainable development and ensure a better future for all.

Principle 22

Indigenous people and their communities and other local communities have a vital role in environmental management and development because of their knowledge and traditional practices. States should recognize and duly support their identity, culture, and interests and enable their effective participation in the achievement of sustainable development.

Principle 23

The environment and natural resources of people under oppression, domination, and occupation shall be protected.

Principle 24

Warfare is inherently destructive of sustainable development. States shall therefore respect international law providing protection for the environment in times of armed conflict and cooperate in its further development, as necessary.

Principle 25

Peace, development and environmental protection are interdependent and indivisible.

Principle 26

States shall resolve all their environmental disputes peacefully and by appropriate means in accordance with the Charter of the United Nations.

Principle 27

States and people shall cooperate in good faith and in a spirit of partnership in the fulfillment of the principles embodied in this Declaration and in the further development of international law in the field of sustainable development.

Supplementary Resources

Bickerman, Wilfred. *Through Green-Colored Glasses: Environmentalism Reconsidered* (Washington, D.C.: Cato Institute, 1996). 230 pages.

Black, Michael and Fischer, Frank, eds. *Greening Environmental Policy: The Politics of a Sustainable Future* (New York: St. Martin's Press, 1995). 221 pages.

Bolch, Ben and Lyons, Harold. *Apocalypse Not: Science, Economics, and Environmentalism* (Washington, D.C.: Cato Institute, 1993). 139 pages.

French, Hilary. *Vanishing Borders: Protecting the Planet in an Age of Globalization* (New York: W.W. Norton, 2000). 257 pages.

Gelbspan, Ross. *The Heat is On: The High Stakes Battle over Earth's Threatened Environment* (Reading, Massachusetts: Addison-Wesley, 1997). 304 pages.

Goldfarb, Theodore D, ed. *Taking Sides: Clashing Views on Controversial Environmental Issues* (Guilford, Connecticut: The Dushkin Publishing Group, 1995). 358 pages.

Huber, Peter. *Hard Green. Saving the Environment from the Environmentalists: A Conservative Manifesto* (New York: Basic Books, 2000). 224 pages.

Schneider, Stephen H. *Laboratory Earth: The Planetary Gamble We Can't Afford to Lose* (New York: Basic Books, 1997). 174 pages.

Watson, Robert T., John A.Dixon, Steven P. Hamburg, Anthony C. Janetos, and Richard H. Moss, *Protecting Our Planet, Securing Our Future: Linkages Among Global Environmental Issues and Human Needs* (United Nations Environment Program, U.S. National Aeronautics and Space Administration, The World Bank, 1998). 95 pages.

Information on the World Wide Web

United Nations Environment Program (http://www.unep.org/)
provides current events updates, data, and links to all UN environment activities and meetings

Carbon Dioxide Information Analysis Center (http://cdiac.esd.ornl.gov/)
provides U.S. and world current and historical data on greenhouse gas emissions and their effects

World Resources Institute (http://www.wri.org)
environmental think-tank offering analysis of events, explanations of trends, and extensive data

Energy Information Agency: Annual Energy Review (http://www.eia.doe.gov/emeu/aer/contents.html)
provides current and historical U.S. data on energy production and use and their environmental effects

UN Johannesburg Summit Report (http://www.johannesburgsummit.org/index.html)
provides analysis of events at the summit, outcomes, and future goals

Intergovernmental Panel on Climate Change (http://www.ipcc.ch/)
provides scientific, technical, and socio-economic data and analysis as well as reports on the IPCC meetings

White House Environmental Policy Page (http://www.whitehouse.gov/infocus/environment/)
explains current U.S. environmental policies and provides links to relevant U.S. agencies

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EFF-089 (1/2003)